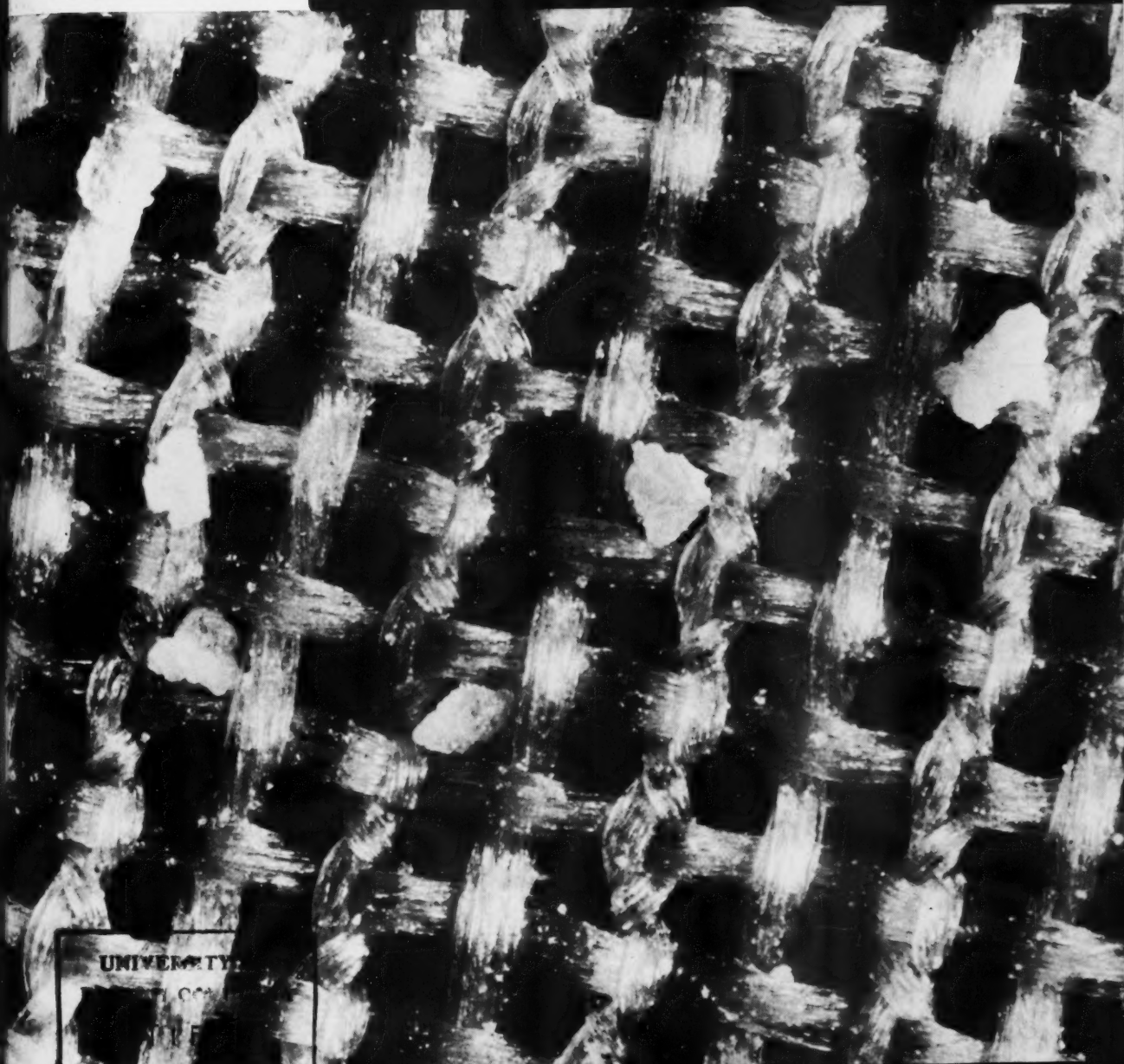


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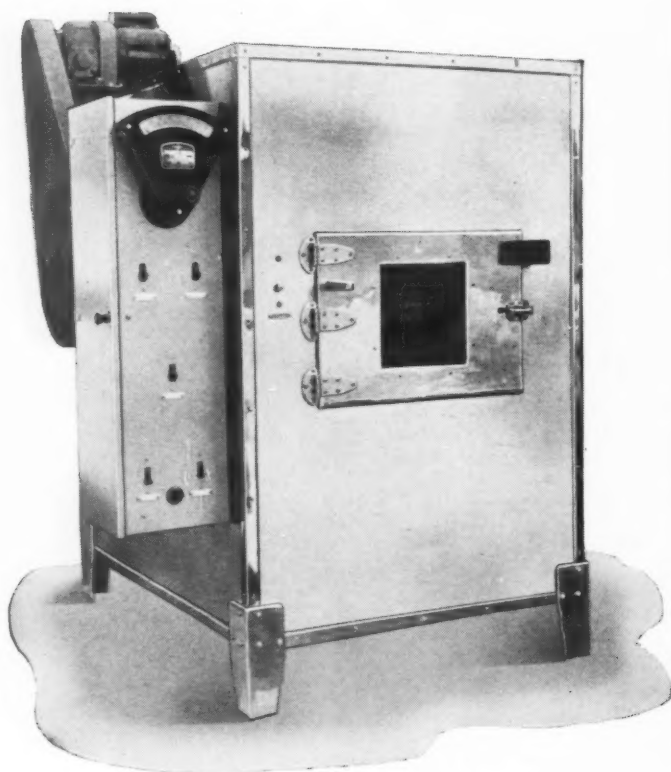


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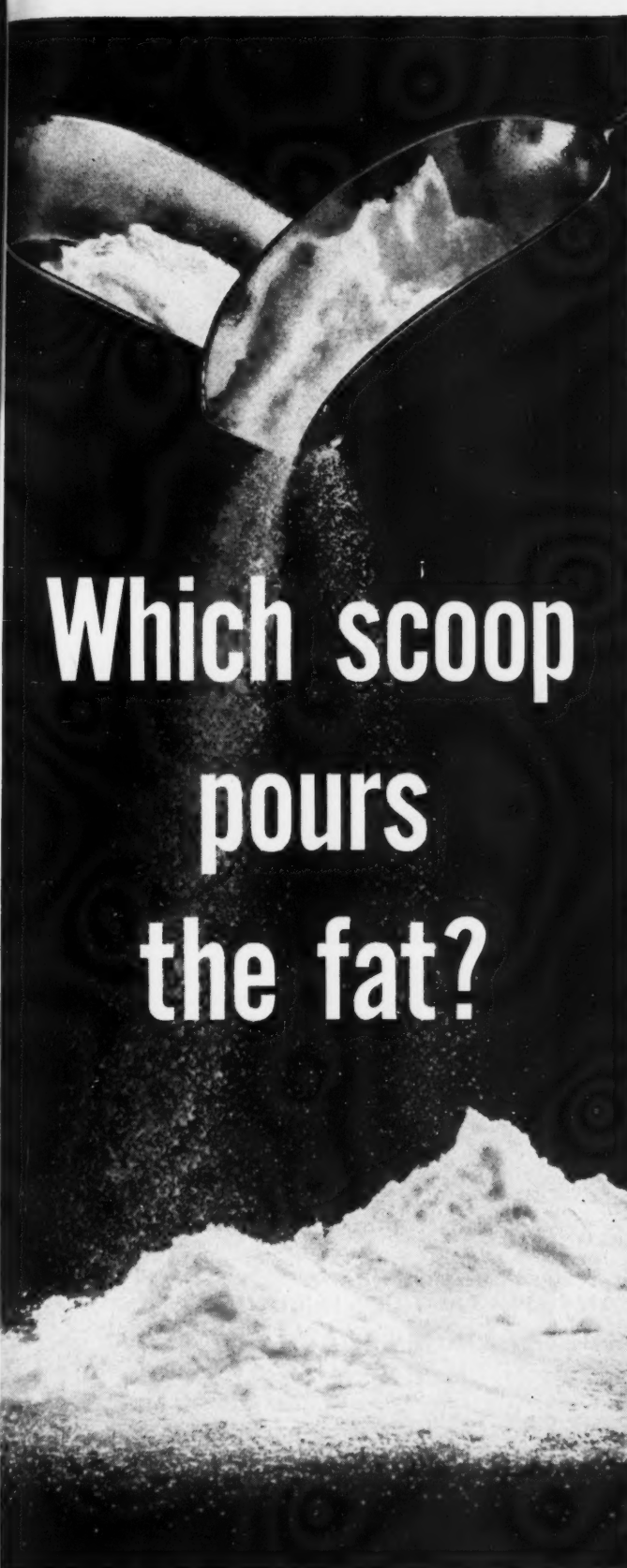
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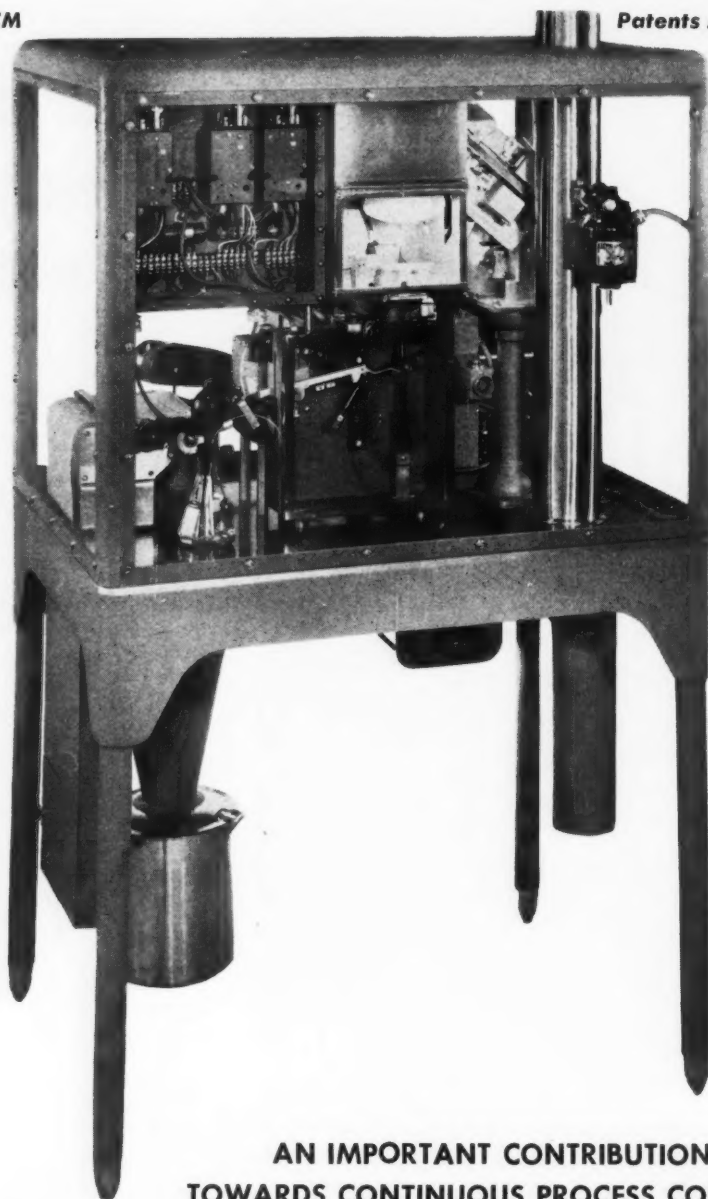
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CEREAL SCIENCE

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FEATURES

- Eggs in the Food Industry. Richard H. Forsythe 211
Dynamic Shifts in the American Cereal Economy. Karl Brandt 217

TECHNICAL SECTION

- Evaluation of Flour and Dough Performance and Bread Quality. Sven Hagberg. 224

DEPARTMENTS

- Editorial 209 Overseas Reports 232
People, Products, Patter 228 AACC Local Sections 233
Book Reviews 236

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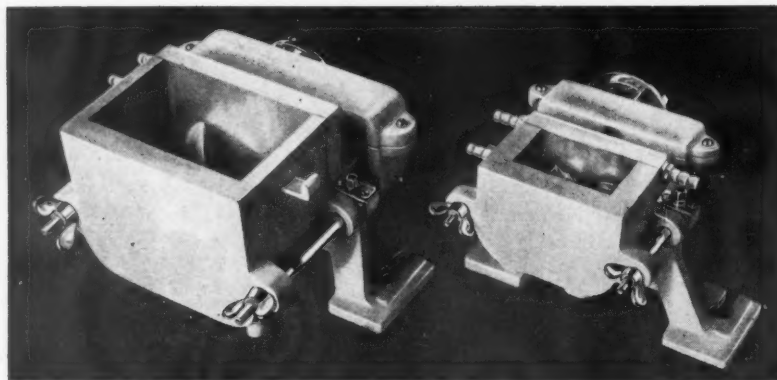
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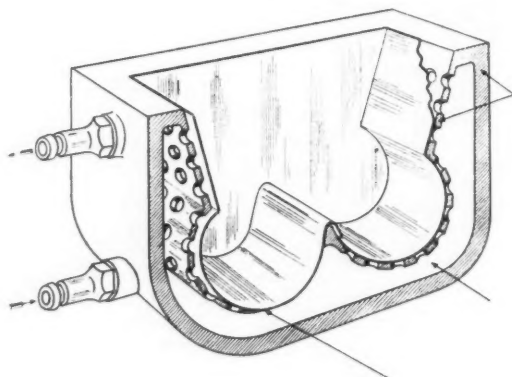
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NUTRITIVE VALUE OF bread was discussed at a recent symposium held at Cambridge University, England, and reported on in this issue by Dr. C. R. Jones, our *Corresponding Editor* in Britain. Cereal chemists have long had an active interest in and have contributed to the development of the science of nutrition. A meeting of the type in which our British colleagues have participated is further evidence of this. No other class of foods contributes so much to the feeding of man and of domestic animals throughout the world as do cereals. Nevertheless, with popular interest in diet and its relation to human health at an all time high, the nutritional role of cereal products is frequently misunderstood or even maligned.

Nutrition science has passed through several phases in developing to its present degree of sophistication. Along the way it was necessary to study foods or constituents of foods by themselves to learn about vitamins, minerals, and amino acids, what part they play in metabolic functions, and what amounts are required to avoid typical deficiency symptoms. Today the goal of research in human nutrition is the more difficult one of learning the relation of diet to maintaining top physical and mental vigor throughout a longer life. This is likely to be attained by proper balance of many foods in the diet rather than by undue emphasis on a single food or class of foods.

Food fadists prey upon the public's ignorance. Sincere people with the best intentions frequently spread false or misleading information about foods. We believe there are three things that cereal chemists can do in the interests of advancing better human nutrition. *First*, develop the ability to distinguish reliable information gleaned from well-designed experiments from half truths taken out of their original context. *Second*, to give reliable information or name authoritative sources of such information when our employers, friends, or the public ask questions concerning the nutritive properties of our products. *Third*, aid the efforts of workers in nutritional research and dietetics by sharing our knowledge of the composition and characteristics of the materials and products with which we work.

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Eggs in the Food Industry

EGGs AND EGG products constitute one of the most complex and expensive ingredients which the baking technologist must investigate in problems of formulation and quality control. A need has been expressed for information to help attack these problems more logically and systematically than is now generally being done. While there is a wealth of information in scientific journals and textbooks (13), the busy cereal chemist has little time to study and evaluate this literature even when it is available to him in well-established libraries, and many in the cereal industry do not have access to these sources. It is the purpose of this paper to present and summarize some of the technical information concerning the basic physical, chemical, and biological properties of eggs and egg products and the factors affecting their use in the food industry. While the use of shell eggs in the industry is very low except in small bakeries, some of the quality factors that must be considered in the consumption of shell eggs will be mentioned.

of quality in shell eggs, as well as contributing to the bacteriological state of the egg and its contents.

When an egg is broken out on a flat surface, as for frying, a certain amount of thick gelatinous egg white stands up around the yolk. During formation of the egg in the body of the hen, the white laid down in the magnum portion of the oviduct is all thick; at a later stage in development, watery substances are transferred into the egg from the oviducal wall and a portion of thin white results. This process of "thinning" is a continuing one after the egg has been laid, and the amount of thick white is dependent upon age and storage conditions. Major factors contributing to this thinning and consequent loss of quality are high temperatures and transfer of carbon dioxide (with a resulting change in pH) out of the egg.

This process has been extensively investigated over the past 25 years and almost 100 papers have been published describing conditions and treatments for prevention of the re-

sulting quality loss (13). It is now generally recognized that any process which seals the pores of the eggs, if properly executed, will ensure greater retention of the thick consistency of the white.

One of the basic factors in classifying (candling) shell eggs for quality is the structure and thickness of the white. The yolk, or ovum, is surrounded with a membrane which is semipermeable in that water can pass through, leaving the proteins and fats more or less intact within the yolk. This osmotic process results in a weakening of the membrane, again depending on time and temperature, and as the egg ages the yolk loses the upstanding characteristics necessary in high-quality shell eggs.

The relative proportion of white and yolk is of considerable importance to users of egg products of all kinds. Since this proportion is relatively constant, the demand situation for one must be proportional to the other or large price differentials result. Many cereal chemists involved in formulations were made aware of

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SHELL

SHELL MEMBRANE

AIR SPACE

EGG MEMBRANE

CHALAZA

CHALAZA

CONCENTRIC LAYERS OF LIGHT AND DARK YOLK

LATEBRA

INNER THIN WHITE

THICK WHITE

OUTER THIN WHITE

* Director of Central Laboratories, Henningsen, Inc., Springfield, Mo.

this situation during the past few years when the growth of the angel cake mix required larger quantities of egg whites, with no accompanying increase in the demand for yolk, either frozen or dried. A considerable amount of research effort has been expended in attempts to correct this unbalance by developing more uses for yolk.

It is not generally understood that the relative proportion of whites and yolks differs when eggs are broken out in the laboratory and in the commercial plant, as well as when eggs of different age are broken. In commercial breaking operations, the albumen (egg white) comprises approximately 55% of the total edible portion, which is almost 10% less than when eggs are broken in the laboratory. This is almost entirely due to the mechanical adhering of the egg white to the yolk in commercial high-speed operations. For example, the "45% solids egg yolk" common to most bakery operations contains approximately 14.5% egg white, and "43% solids egg yolk" contains almost 20% egg white. These features are very important to certain users of egg products and are sometimes overlooked by research workers in carrying out projects involving egg yolks. This fact also constitutes a problem for manufacturers of baby foods who must keep the amount of whites at a minimum because most babies are sensitive to several of the egg white proteins.

Five quality factors appear to be of primary importance to the users of egg products: chemical composition; nutritive value; and microbiological, organoleptic, and functional factors.

Chemical Composition

The chemical composition of egg white is of much less interest than that of yolk, but in many respects it is extremely important. Liquid egg white consists of:

	%
Water	87.8
Solids	12.2
Protein	10.7
Free glucose	0.38
Sodium chloride	0.3
Cholesterol	0.002

Free glucose is of primary importance to the user of egg-white solids. Their shelf life is almost entirely dependent upon the "browning" or Maillard reaction which takes place between the free glucose and the pro-

teins. The products of this reaction are brown in color, are insoluble, and have an undesirable flavor. In commercial processing of egg-white solids this glucose is removed in one way or another. The three basic procedures (6) for this removal have been discussed elsewhere in detail but are generally grouped as: bacterial fermentation (either controlled or natural); yeast fermentation; and enzymatic oxidation of the glucose.

The low level of cholesterol, 0.002%, indicates that naturally occurring egg white is almost devoid of fatty materials. During commercial operation the fat content, as measured by the amount of yolk, is sometimes increased by poor handling practices to as much as 0.05%. This added yolk definitely retards the whipping ability of the egg white and may be one of the most troublesome factors in the use of frozen egg in the baking and candy industries.

Many tests have been devised to measure this factor. Until very recently none were satisfactory, but a sensitive test has been developed for quantitative determination of minute amounts of yolk in egg white (4). This method utilizes the formation of the monomolecular layer of the extracted fat on a prepared surface. The area is determined, compared with the areas formed by known quantities of yolk fat, and an accurate estimate of contaminating yolk made. This procedure is proving to be a valuable tool for research and quality control.

The chemical composition of liquid egg yolk is as follows:

	%
Water	49.5
Solids	50.5
Fat	31.9
Protein	16.3
Sodium chloride	0.3
Glucose	0.17

These are laboratory figures, and the solids content of commercial egg-yolk products is reduced to the usual 43-45% level by the process of adhering egg white. Free glucose in yolk is of some importance in the manufacture of egg-yolk solids, but because of the smaller concentration has not played the important role that it has in the manufacture of egg-white solids. This glucose is removed in essentially the same manner as in the white, resulting in a so-called "stabilized" yolk of greater shelf life. Yolk is a much more complicated

chemical system because of the high fat content. The lipids of the egg yolk are composed essentially as follows:

	%
Total lipids (solids basis)	64.9
Glycerides	40.3
Phospholipid	21.3
Lecithin	13.1
Cephalin	5.4
Cholesterol	3.6

Of the fatty acids, 30% are saturated and 70% unsaturated fatty acids. Isolated egg oil is very sensitive to oxidation and softens at about 80°-90°F. The lipid components of the yolk are one of the most important factors from the standpoint of shelf life of egg-yolk solids. As usual in substances of this kind, the shelf life can be extended by refrigeration, gas packing, low-moisture drying, glucose removal, or combinations of these treatments.

Nutritive Values

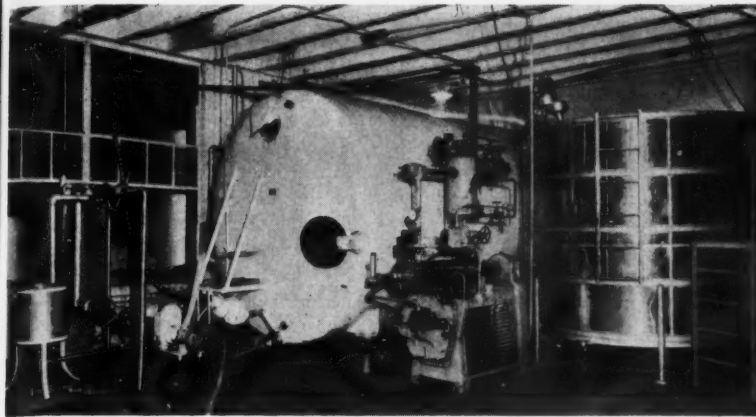
Consumers of shell eggs are more concerned with the nutritional qualities of egg products than are egg products users, since more bakers and candy manufacturers use eggs for their functional rather than nutritional qualities. The egg as a whole is an excellent source of protein and the protein is of the very highest biological efficiency. The yolk supplies fat and the low carbohydrate content makes it very desirable for special diets. From a mineral standpoint eggs are valuable for phosphorus, magnesium, potassium, sulfur, iron, copper, and many trace elements.

Eggs are a particularly good source of the A and B vitamins, vitamin D, choline, pantothenic acid, inositol, and folic acid. The old major vitamin deficient in the egg is vitamin C. It has been suggested that the cereal technologist might make better use of the information available regarding the nutritional qualities of eggs in many of his products.

Microbiological Properties

The avian egg is extremely interesting from the bacteriological point of view. The process of egg formation is completely aseptic in all healthy poultry. Certain diseases do result in contamination of the egg yolk, but these diseases are first manifested by unhealthy birds which are usually removed from the flocks for that reason. At the actual moment of laying even the shell is sterile; contamination takes place after this, on farms where dirty nesting materials

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Liquid storage, processing, and cooling equipment, all constructed of sanitary stainless steel. Plate pasteurizer at left is part of equipment used to reduce bacteriological levels. Liquid egg must be kept cold at all times to ensure top-quality egg solids.

come in contact with the egg. Actually the egg white has several bacteria-inhibiting substances which are very important in holding down invasion attempts. From the egg-products standpoint several procedures are used to control the bacteriological quality of eggs, since there is bound to be some contamination before the egg reaches the breaking plant. Sanitation is equivalent to that in well-regulated dairy plants to prevent further bacterial growth.

The tremendous advances in sanitation made by the egg industry since the war years have resulted in better sanitary qualities in all egg products. Relatively new in bacteriological control of egg products is pasteurization. It is difficult to pasteurize egg white because of the low temperature of heat denaturation (125° – 130° F.) and the resulting loss of functional qualities, but whole egg and egg yolk can be pasteurized satisfactorily in "high-temperature, short-time" units at about 143° F. for 3 to $3\frac{1}{2}$ minutes with 99.9% bacterial reduction. Spray-drying usually further reduces the bacteriological population of egg products, even after the drying operation is completed by oxidation. The actual heat applied to the egg in the operation of spray-drying is relatively minor, since evaporation cools the small particles, and much of the reduction observed during drying must be due to this oxidation effect.

In the past few years there has been much discussion about possible pathogenic organisms in egg products. It is well known that poultry is one of the natural reservoirs for *Salmonella* and these organisms have been found in egg products. However,

food poisoning from contaminated egg products does not appear to be likely with eggs that have been properly processed and properly handled by the consumer. The poultry industry is aware of this problem and a great amount of research is being carried on to obtain further information on *Salmonella* contamination of egg products and possible methods of elimination. In general, the *Salmonella* content of egg products is even lower than many published reports would indicate, much of the research having been carried out with low-quality eggs dried during World War II. The level of *Salmonella* contamination in the bulk of commercial egg solids is probably less than one organism per gram. Contrary to popular belief, the coliform count as an index of contamination in the egg industry is probably not a good one. It has proved its merit in the dairy field, but as far as eggs are concerned it would be much more desirable to use other organisms as an index of sanitation.

Organoleptic Properties

The organoleptic qualities of egg products—flavor, odor, and yolk color—have received more attention in the past than probably any other quality factor. Feed composition is the only major factor affecting yolk color. As more green feeds (containing xanthophyll and carotene) are consumed by poultry, yolk color is heightened. Color is a real problem to the egg processor because the consumer of shell eggs prefers a light yolk and the egg products user prefers a dark yolk. Probably no other problem is more important in the

noodle industry. Odor and flavor can also be altered by feeding practices, but this problem is of minor importance today. Formerly when birds were allowed to run more or less uncontrolled and allowed to eat almost anything that grew (wild onions, for example), eggs often had very poor flavor. Cod liver oil and other fish meal products of poor quality affect flavor if fed in excessive quantities.

One of the factors that formerly were of most importance to the flavor of shell eggs was the condition of holding and storage. The egg is very susceptible to contamination by off-flavors and/or odors in warehouses, and if stored close to odoriferous materials will pick up an undesirable taste. Improvements in warehouse procedures have essentially eliminated this problem, and recent research has shown that shell eggs can be held for several months, under proper conditions with no deterioration in flavor.

To the user of frozen egg products the most important difficulty from a flavor and odor standpoint has been due to the development of microorganisms, which often has resulted from improper thawing of frozen egg products in bakeries but also can stem from improper freezing of eggs in processing plants. This organoleptic quality in yolk and whole egg can be controlled by pasteurization, since bacterial counts are greatly reduced and freezing and thawing become less critical. Spray-drying generally results in a product of improved organoleptic quality, since odors that might have been developed are removed with the other volatile constituents. Egg solids, of course, are subject to deteriorative reactions at higher temperatures, resulting in poorer organoleptic quality. The chemistry of the deterioration has been thoroughly reviewed by Lightbody and Fevold (8).

Functional Qualities

Those qualities that cereal chemists find of greatest interest, and probably their greatest problem, are the group usually called functional. Many bakery and confectionery products could not be made without eggs; others would have quite different properties if eggs were reduced or left out of their formulas.

We shall discuss only egg white in detail, but should at least refer to the functional qualities that are expected

of yolk. Egg yolk is an excellent foamer, in a sponge cake for example, but its primary use is for emulsification. As was pointed out in the section on chemical composition, egg yolk is very rich in phospholipids and contains a large amount of lipoprotein. Frozen, and to a lesser degree dried, yolk as it is received by the baker is already a well-started and stable emulsion. The primary use of this emulsification ability is in mayonnaise, but many other applications are familiar to cereal chemists. The third important property of egg yolk is heat coagulation of the proteins. This begins at 145°-150°F. and, of course, the rate of denaturation increases very rapidly with increases in temperature. Again, it should be noted that the amount of white that might be contained in the yolk may play an important part in heat coagulation, since it coagulates at a lower temperature.

The use of egg white in the candy and the bakery trade is based primarily on its foaming ability and the heat coagulation property of the proteins. The most common question that arises concerning the use of egg white is "Why does egg white foam?" We might briefly examine the requirements of a foaming agent. While probably greatly oversimplified for the biophysical chemist, the essential requirements for foaming are: low surface tension, high viscosity, ease-of-surface denaturation, and structure stabilized by heating.

Egg white is a very complex system of proteins consisting essentially of:

	%
Ovalbumin	65.0
Ovomucoid	9.0
Globulin	9.0
Conalbumin	14.0
Ovamucin	1.6
Lysozyme	3.4

The role of these various proteins in foam formation has been recently reported in an excellent piece of research from the Western Utilization Research and Development Division at Albany, California (10). According to this report the globulins are primarily responsible for lowering surface tension (and increasing viscosity) to the point where rapid incorporation of air and the initial phase of foam formation are possible. As foam develops, ovomucin (and perhaps other proteins) surface-denatures and begins to form a solid film which contributes to the stability of the unheated foam. Final-

ly the ovalbumin, which is readily heat-coagulable, sets up in the oven to a solid structure supporting not only the egg white but considerable quantities of sugar and flour, as in angelfood cake. The major work of most egg technologists has centered around altering the properties of these proteins in attempts to improve foaming properties of the egg-white solids.

It might be of interest to evaluate some of the specific processing variables encountered in the manufacture of egg-white solids, that affect the performance of egg white in baked goods. Since performance requirements vary considerably from one baked product to another, the function of egg white in angelfood cake has been chosen as an example. It is, moreover, one of the most widely used applications, and this product utilizes more of the properties of egg white than any other baked item. In any consideration of an ingredient in a baked product one must, of course, consider the complications that result from the interaction with other ingredients of a formula. In angelfood cake we have a smaller number of ingredients; this makes the system relatively a more simple one, but still leaves us with a group of ingredients of a highly complex nature. Because of this complicated set of conditions, unfortunately, we have in many instances had to draw our conclusions from results which may actually be a conglomeration of opinions or educated guesses rather than scientifically proven facts. The length of time required to beat the egg white and the final volume, grain, and texture of the finished angelfood cake must be considered. It is commonly accepted that the performance of egg white exhibits its action on each of these attributes. Unfortunately, some workers have concluded that the other cake ingredients do not affect these attributes significantly. Cereal chemists realize this is not the case and that the leavening and the amount and type of sugar, as well as the amount and type of flour and/or starch ingredients, do play an extremely important role, especially in the final volume and texture of the cake.

pH and Acid Effects

Of considerable importance in the liquid treatment of egg white is what

we shall call pH and acid effects. Early Chinese albumen processors knew that albumen that was allowed to ferment, thereby increasing its acidity, whipped up better than one which had a higher pH. Some American workers formerly attributed this to the removal of glucose, but it is now definitely known that the effect of glucose, as indicated above, is a completely separate one and as such has no effect on the performance. The Chinese workers also knew that the length of time that egg white was held at a lower pH level had an effect on its whipping performance. The acid-binding properties of various proteins have been extensively investigated (14). These fundamental studies have indicated a very definite acid-binding power for different proteins and for different acids. From the practical production viewpoint this information can be utilized, and it manifests itself on the effect of foam stability and on the temperature of heat coagulation.

These effects are completely different and separate from what is anticipated from the hydrogen-ion concentration. From the work of Neurath (12) and others (5), it is known that the rate of denaturation from heat as well as from other forces is generally greater when the pH of a protein solution has been adjusted to its isoelectric point. Thus, we have a combined effect of the anion and cation of the acid added to the egg white during processing, whether it is added by the fermentation organisms or in the form of the pure food acid by the processor.

The effect of acid added to the "A" mix portion of an angelfood cake mix is similar. For example, phosphoric acid salts produce meringues which are more stable than those produced by tartaric acid salts. The effect is noticeable even when the hydrogen-ion concentration is the same. Certain of the complex phosphoric acid salts result in more rapid foam formation as well as affecting their stabilizing influence.

The acid of choice for the addition of egg white during processing is either lactic or citric acid. At the present time these acids seem to fill most of the requirements of the present-day angelfood cake. Citric acid, of course, has the added advantage of sequestering any iron that might be present from contaminated equipment in the bakeshop, eliminating the

possibility of the well-known iron-conalbumin reaction which gives a distinct pink color to meringue.

Additives

It has recently been discovered that certain other chemicals when added to egg white enhance the whipping performance. Mink (11) in 1939 patented the idea of adding anionic surface-active agents to egg white and presented results which showed significant improvements upon the addition of levels no greater than 0.1% on a solids basis. Very little had been done commercially in this respect until the angelfood cake mix manufacturers began to demand greater and greater foaming performance from products which had been primarily designed for the manufacture of candy. This demand set off a large-scale investigation of anionic surface agents as well as other chemical additives which might result in better performance.

In 1950 a patent was issued to Standard Brands (7) for the inclusion of triethyl citrate into egg white with results paralleling those of the addition of the anionic compounds.

Little or no scientific information is available to indicate the mode of action of these chemicals. Lundgren and co-workers (9) have studied the effect of Naconal on egg albumen in an attempt to produce synthetic fibers. From their work it might be concluded that the effect of anionic surface-active agents is to increase the ease of surface denaturation to permit a more stable foam to be formed more rapidly.

An unintentional additive which has a decided effect on egg white, as indicated earlier, is fat. The fat of egg yolk significantly retards the formation of foams and decreases their stability. The anionic surface-active agents and triethyl citrate overcome a portion of the damage resulting from yolk fat. It is also apparent from our observations that certain of the fats in flour contribute to instability of egg-white meringues. This is a real problem in the formulation of an angelfood cake mix. Again very little is known concerning the theory of the mode of action of these fats, but a considerable amount of research is under way in various institutions to investigate this phenomenon.

A real criticism of much of the

egg-white research that has been carried on in academic institutions is that much of it has been undertaken without a full knowledge of the effect of fat and these other chemical additives on commercial products. Results have been obtained which cannot be interpreted in the light of commercial practices.

Atomization

It has been commonly accepted from the early days of albumen drying that it was possible to make a more satisfactory whipping product with pan-drying than with spray-drying techniques. Almost all of the Chinese albumen formerly used in this country was pan-dried. As the need for better sanitation and larger quantities of egg-white solids developed, the inefficient and costly pan-drying procedure gave way to spray-drying. It was immediately noted that it was difficult, even impossible at times, to produce a satisfactorily performing product.

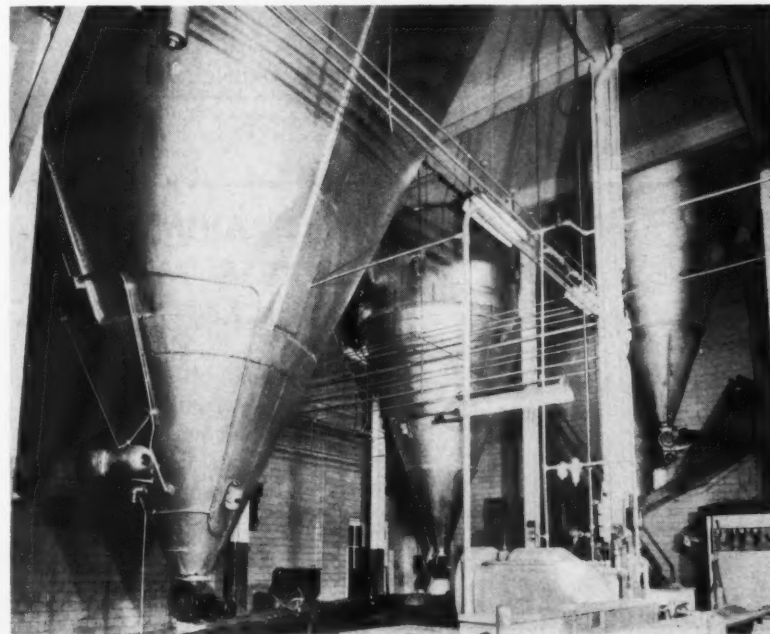
Bergquist and Stewart (2, 3), among others, investigated the reasons for this deficiency and concluded that the atomization during spray-drying was responsible for the poorly whipping product. Atomization creates tremendous surface areas which contribute to the loss of beating power, probably because of excessive surface denaturation. These

workers also show that not only the amount of surface formed but also the rate of surface formation was involved. The more rapid the formation of large surface areas, the poorer the beating time. They suggested that if spray drying could be accomplished with less surface damage due to atomization, a satisfactory product would result. It has been the trend during the last five years to reduce atomization pressures as well as to develop new devices causing less atomization damage. It is now possible, with the combined use of acid effects, additive effects, and atomization effects, to produce an egg-white product which is actually superior in performance to natural fresh egg white.

Post-Drying Treatments

The effect of heat treatments on dried egg albumen has long been considered, since the egg white is subjected to certain quantities of heat during the spray-drying operation. Banwart and Ayres (1) at Iowa State College carried out a comprehensive series of studies to determine the effect of heat treatment on the microbiological properties of egg-white solids as well as on the functional properties. Their studies showed that it was possible to significantly reduce levels of *Salmonella* at moistures below 6% at 50°C. without hurting

Cyclonic drying and collecting chambers employed in the manufacture of egg solids. All surfaces exposed to egg must be stainless steel to ensure highest quality and freedom from metal impurities.





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Screening and packing operation in which egg products are given final sifting and packed into 150-lb. moistureproof fiber drums.

functional performances. They actually observed an improvement in beating characteristics of albumen held under these conditions. Albumen held at higher levels of moisture suffered a loss of functional performance. It is apparent from their studies that no heat damage results during the actual spray-drying operation. No theories have been advanced for the slight improvement noted during storage, but if we take our clue from the other investigations mentioned, this improvement may be due to the slight and possible selective denaturation of certain of the egg-white proteins.

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Dynamic Shifts in the American Cereal Economy

By Karl Brandt*

THE INVITATION to address the American Association of Cereal Chemists with which I have been honored seems in itself to reflect the desirability of closer relations between chemical and economic research. This applies particularly to the branch of economics closest to the range of chemical research, discovery, and invention—agricultural commodity economics. In fact, there is emerging today a new field of concentration of studies called chemical economics. Scholars roam within it as explorers, meeting with colleagues from either discipline—chemists who are trained in economics, and economists with a fair grasp of organic chemistry. While this exploration concerns terrain adjacent to both disciplines, in the real world this terrain consists of the identical phenomena of human action and their results. Chemistry and economics merely deal with different aspects.

As an agricultural economist I am impressed by the ever-increasing impact of chemical research and subsequent technological innovation on the ordinary, everyday performance of agricultural land utilization in the production of food, feed, and fibers and upon the marketing, processing, and consumption of these commodities. Indeed, it seems to me inescapable that a large part of what is passed on in the written and spoken word as the solid body of economic knowledge is already ob-

solescent, if not obsolete, owing to the progress of chemistry. The pace of basic and applied research plus technical and managerial innovation have already eroded yesterday's solid foundations, and are rapidly building new ones to which the enterprises are being adapted. Enormous quantities of capital are depreciated while greater quantities of new capital are being formed.

In their aggregate, all these activities making up the complex process of a modern industrial nation's economic life change the scenery so fast that keeping up to date on what is going on is a breathtaking task. In many instances the ordinary tools of quantification prove inadequate and the economist, if he is to rationalize what actually is taking place, must have the keenest perception; he must use imagination in the search for clues, and must have a constructive knack of composition or synthesis.

Limited space and the bewildering scope of the shifts require selection of and concentration on those changes, dislocations, and adjustments that weigh most heavily in their economic impact.

Cereals for Food and Feed

The term "grain," or "cereal," lumps together the seeds of seven species of the family of the Gramineae or Poaceae or grasses, and of a member of the family of the Polygonaceae. Agriculturally, these crops fall into four groups: 1) the four small grains—wheat, rye, barley, and oats—each available in a fall-sown winter form with a long vegetation period and a spring-sown form with a short vegetation period; 2) rice; 3) corn, sorghums, and millets; and 4) buckwheat. Wheat, rye, rice, and

buckwheat rank today in agricultural terminology as the "four food grains," while corn, oats, barley, and sorghum rank as the "four feed grains." The four small grains are shallow-rooted crops which will grow in humid-to-arid climates and will mature anywhere from 70 days to 11 months. Rice, as a cereal, is in a class by itself, belonging in tropical, subtropical, or Mediterranean climates, and can be grown like other cereals or on inundated fields. Corn, sorghums, and millets are deep-rooted, intertilled hoe crops that can be grown successfully in climates from tropical to temperate zones, corn requiring much more moisture than sorghum. Buckwheat is a rather unimportant, short-lived leaf plant that will grow in nearly all climates and thrive even on raw soils. All of these crops have been and are grown in the United States—even rice in Louisiana, Arkansas, Mississippi, Texas, and California. Wheat is grown in 40 states, rye in 35, barley in 40, oats and corn in 48 states each; sorghum for grain in 16 states, for forage in 26, and for silage in 22; and buckwheat in 15 states.

These figures indicate how important and widespread the cereals are. During the last 15 years the eight grains have covered roughly an average of 200 million acres, or 57% of a total cropped area (52 crops) of 350 million acres. The farm value of the eight grain crops was 9 billion dollars in 1952, compared with a 21-billion-dollar value for all crops (72 crops including fruits and nuts) or 43% of the total.

Improving Crop Yields

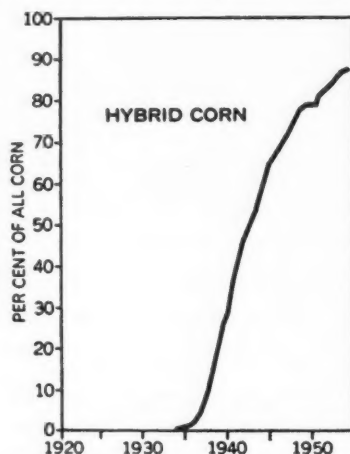
Among the many crops farmers grow, the small grains, as short-lived

* Associate Director, Food Research Institute, Stanford University, Stanford, California. Paper presented at the 42nd annual meeting, San Francisco, May 1957. The charts are presented through the courtesy of Dean Chauncey D. Harris, Division of the Social Sciences, University of Chicago. They are taken from his resourceful survey, "Agricultural Production in the United States: The Past Fifty Years and the Next," *The Geographical Review*, April 1957, pp. 155-93.

annuals, have a relatively low-yielding capacity per unit of land, particularly when compared with such annuals as many of our truck crops or such biennials as sugar beets and potatoes and tuberous sunflowers, or such subtropical or tropical perennials as manioc, sugar cane, plantain-bananas, and such trees as oil palms. Rice, on the other hand, can yield far more than the small grains, particularly when transplanted. Corn and millet, being deep-rooters, can yield more than all other grains. While this over-all, rough comparison of the yielding capacity of all grain vs. that of starchy roots, sugar cane, or tropical trees is basically correct, the yielding capacity does not remain static. Man's effort to improve crop yields has met with amazing success in the cultivation of specific cereals, and is continually changing the relative positions of the types of grain.

The goal of higher yields and better performance for cereals has been approached from many sides, with the alternating and concentric efforts of geneticists, biologists, chemists, physicists, agronomists, and engineers—to name only a few. Progress in basic genetic research and in applied genetics has given the farmer more and more improved varieties of each of the grains. These varieties have, on the whole, a greater capacity to consume nutrients and to respond with greater output to the growth factors they take in. The immense importance of this—to express it in graphic terms—lies in the much more elevated and differently shaped curves of diminishing physical yield increments. The latter behavior of new varieties opens wider and wider frontiers for the American farmer to intensify the cultivation of crops and to obtain, at the same time, a better income. Among results of breeding such grains as corn and wheat is a substantially shorter period from start to maturity, thus in effect expanding the climatic regions in which such crops can be grown. Inbred resistance against diseases and pests, low temperatures, excessive drought or moisture, soil acidity or alkalinity, and improved quality of the grain have also been gained for specific new varieties. One of the greatest forward steps has been the introduction of a technique in plant production known for generations in

animal husbandry—the use of hybrids, i.e., bastard seed, created for one season's use by crossing two different purebred or homozygous strains of the same variety or different varieties. This method alone has revolutionized the production of corn in this country, and from here the practice is being carried into many others. Today virtually the entire U. S. corn acreage is sown with hybrid seed. Hybrids, having



Hybrid corn, percentage of all corn acreage, 1933-1954.

a shorter growing time by about 2 weeks, can be sown later or harvested earlier before frost can strike, and hence, planted in areas where the growing season is too short for ordinary varieties of corn.

Improving Cultural Practices

Thus, having plants with better photosynthetic capacities, growers could improve cultural practices—i.e., deeper plowing, the use of subsoilers, more cultivation, and more prompt harvesting. The immense expansion of mechanical traction power and labor-saving machinery has made this possible with drastic cuts in the amount of labor applied per acre. In one generation the tractor fleet has increased from almost none to 4.8 million units, farm-trucks from a few hundred-thousands to 2.8 million, combines from a few ten-thousands to 960,000, and the number of corn-pickers from a few ten-thousands to 660,000.

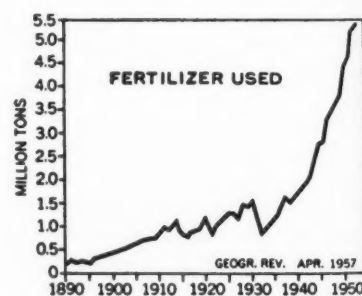
Cultivation and harvesting of grain had reached the point of total mechanization long before they were gradually or partially attained for the other crops, thus cutting costs despite higher yields. Among the

mechanized methods, seeding, fertilizing, and the application of pesticides by airplane or helicopter are the most spectacular. In California rice is seeded mostly by plane.

Advances in Plant Nutrition

Plant nutrition is advancing rapidly. Since the end of World War I improved methods of producing nitrogen from the air have been perfected for producing a greater variety of more and more useful N-compounds as fertilizers and fertilizers with a higher concentration of nitrogen. By-product nitrogen from coke ovens as well as from petroleum distillation or from cracking lignite and bituminous coal, jointly with primary nitrogenous products, has become available in ever-increasing volume at prices which have been rising far less than the majority of other farming costs and the prices of farm products. The availability of anhydrous ammonia gas and the discovery that it can be cultivated as gas into the soil or added to irrigation water have further reduced costs of application.

With a total use of about 23 million tons of all commercial fertilizers, U. S. agriculture at present applies to crops close to 2 million tons of pure nitrogen equivalent. According to European rules-of-thumb, one ton of nitrogen will produce on the average 20 tons of grain.



Commercial fertilizer consumed in the United States, 1890-1953, in tons of nitrogen, phosphoric acid, and potash nutrients contained.

While a large part of the 2 million tons of nitrogen are applied in this country to crops other than grain, it seems nevertheless safe to assume that a considerable and an increasing amount of our grain output is being produced with nitrogen fertilizer. Behind this lies the fact that all grasses are voracious consumers of nitrogen, in contrast to leguminous plants which respond particular-

ly to phosphorus and potassium because symbiosis with azotobacter in their root nodules provides their nitrogen requirements. The increased use of phosphates, potassium salts, leguminous green manure, and soybeans in the rotation with grains has also improved grain nutrition.

Chemistry has given the farmer additional powerful means for boosting grain yields and curtailing unit costs in the form of highly effective pesticides against nearly every type of damaging animal, insect, bacterium, and fungus, and against the spreaders of virus diseases. At present about 250 million pounds of pesticides are used in agriculture. Furthermore, chemistry has created, in very recent times, more and more selective weed-killing substances, chiefly hormones and related compounds which are harmless to Gramineae but deadly to leafy plants.

Technological Innovations

Another momentous expansion of agricultural - production techniques has taken place in irrigation. With large-diameter, lightweight aluminum pipe, patent coupling, and improved sprinkler heads, water is being applied to plants through the air without working the soil. This has expanded its applicability and reduced costs. Prior to this set of inventions, irrigation was generally too expensive for cereals and was reserved for heavier-yielding crops. But today, with low-priced nitrogen, reduced costs, and higher-yielding varieties of grains, irrigation has entered the production of cereals. Corn, with its high yields, is the most promising species. But in several Western states sprinkler irrigation is now applied to wheat, barley, and oats. With the generally prevailing tendency to boost yields per acre in order to reduce fixed overhead costs per unit of product on U. S. farms, I anticipate the gradual expansion of supplementary irrigation for corn and even some of the small grains, because the marginal productivity of small amounts of irrigation water during critical weeks of the vegetation period, combined with nitrogen, is very high. Irrigation of cereals becomes most feasible, of course, where the grain farms also grow high-yielding irrigated crops such as cotton, sugar beets, or potatoes, since the capital invested in irrigation

equipment can be written off on those. In the Mexican states of Sinaloa and Sonora, large areas of wheat are grown in alternation with cotton even with flood-irrigation.

Another trend in technological innovation has made general the use of labor-saving devices in harvesting and transporting grain. The long road from the scythe via the horse-drawn reaper and the tractor-drawn binder-mower to the self-propelled combine has resulted in the penultimate in labor saving. But combining saves more than harvesting and threshing labor: it leaves the straw in the fields and eliminates the transportation of grain shocks to the farm and of barn litter to the fields. The mechanical corn picker has made the jump directly from hand-picking to complete machine harvesting. Artificial drying of grain with cold or hot air has expanded the climatic area for combining as well as for mechanical corn-picking. Instead of "sweating" slowly in the straw in bins and being threshed during the winter, the grain now moves in a "flash flood" at harvest time directly from the fields to the elevators on farms or at the railroad tracks. The practice, a costly but time-honored nuisance, of handling grain in sacks is gradually being abolished by more and more bulk handling in transport and storage. This involves a considerable capital investment in rolling stock of all sorts, in pneumatic or other conveyors, and in bins, but it cuts handling costs per unit.

Acreage-Yield Trends

The course of our grain acreage, grain yields, and grain output shows for the 10-year period 1866-1875,¹ the five-year period 1946-1950, and for the year 1954 the following progression: the harvested area for the four food grains increased from 25-74 to 58 million acres, or by 130%, and for the four feed grains from 52-142 to 146 million acres or by 180%; or for all grains from 77-216 to 208 million acres or by 170%.

The yields in bushels per acre moved for the same intervals as follows:

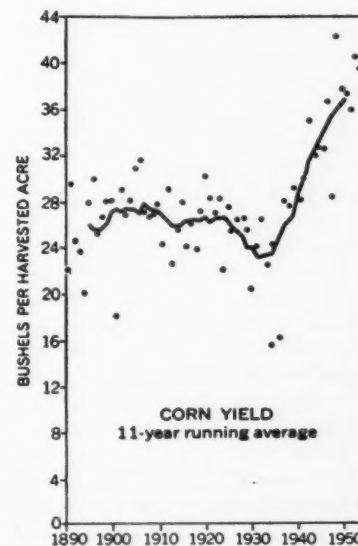
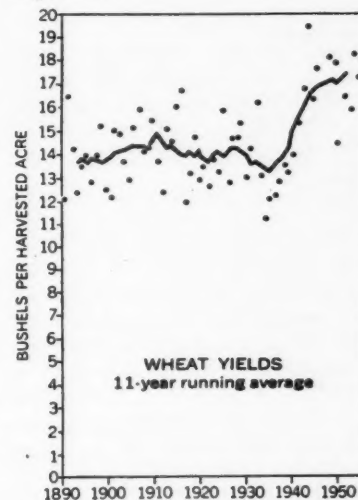
¹ Researchers in grain economics agree that the 1866-1875 figures understated the acreage. Furthermore, grain acreage expanded into semiarid regions. Both factors diminish the statistical appearance of the degree of yield increases. The actual yield increases in the original regions would prove to have been much greater.

	1866-75 Bu/A	1946-50 Bu/A	1951-53 Bu/A	Increase 1866-1953 %
Wheat	12.3	16.8	17.9	45
Rye	10.8	12.2	12.8	18
Buckwheat	13.6	16.9	18.4	35
Corn ^a	25.6	36.6	38.6	50
Sorghum ^b		19.6	19.0	52
Barley	21.7	25.9	28.0	29
Oats	26.5	33.9	34.1	28
Rice	1,644	2,062	2,423	47

^a Yield for 1948, 42.5 bu/A.

^b Yield for 1926-1930, 12.5 bu/A.

The greatest advancements in the yield during this 90-year period are those of sorghum (52%), corn (50%), rice (47%), and wheat (45%). Yet even the increases for barley (29%) and oats (28%) are impressive.



Average yields of two crops, 1890-1955. Dots represent average yields for individual years; line is 11-year running average centered on the midyear.

During the 90-year period, production changed as follows: The output

increased for the four food grains by 297%, for the four feed grains by 260%, and for all grains combined by 267%. Thus a 170% increase in grain acreage was accompanied by an increase of 267% in total output. At present the increase in yields tends to continue, while the acreage may remain at its present level or even fall below it for some years.

velopment created the need for it and gave him at the same time the rising purchasing power to exercise his changing preference.

According to Bennett's Law, discovered and formulated in 1941 by my colleague at Stanford University, Merrill K. Bennett, nations change their diet, with rising income, toward a diminishing portion of calories

Shifting Utilization

While the starchy staples such as corn meal, wheat flour, semolina, rolled oats, and potatoes excel in priceworthiness in terms of retail prices per 1,000 calories, above all other food their per-capita consumption has been continually declining in this country. The proportion of grain-products calories as percent of total calorie consumption has, from 1875 to 1955, fallen from close to 50% to 22% (1). This has resulted in the decisive feature in the grain economy that, in spite of the steadily rising trend of population growth and of grain production (with only a brief interruption of the grain trend during the drought years 1934 to 1936), the total human consumption of grain products has remained almost stable for the last 50 years, hovering between 29 and 24 million tons per year. As the per-capita consumption of all grain products declined from 1,692 calories in 1879 to around 740 calories in 1953, the proportion of wheat products increased more and more, chiefly at the expense of corn products. Yet with rice and oatmeal gaining slightly, barley and rye flour losing slightly, and buckwheat on the verge of disappearing, the per-capita consumption of wheat flour and semolina declined from 225 pounds per year in 1879 to 129 pounds in 1953.

It may be mentioned that the total consumption of all food calories measured in terms of per-capita food supply at retail level probably de-

Table I. United States Grain Output, 1866-1955^a

	1866-1875		1946-1950		1951-1955	
	1000 bu.	1000 met. T.	1000 bu.	1000 met. T.	1000 bu.	1000 met. T.
Wheat	270,955	7,374	1,184,740	32,244	1,063,918	28,955
Rye	17,210	437	21,875	556	22,184	564
Buckwheat	10,245	223	5,891	128	2,731	59
Rice	.....^b	.....	37,116 ^b	1,684	52,436 ^b	2,378
Total food grains	.....	8,034	.....	34,612	.....	31,956
Corn	1,028,953	26,137	3,097,911	78,691	3,194,429	81,143
Grain sorghum	.....	.....	142,531	3,620	175,368	4,455
Barley	28,246	615	280,661	6,111	314,180	6,841
Oats	281,394	4,084	1,338,644	19,431	1,285,602	18,661
Total feed grains	.....	30,836	.....	107,854	.....	111,100
All grains	.....	38,870	.....	142,466	.....	143,056

^a Data for 1866-1875 from U. S. Department of Commerce, *Statistical Abstract of the United States*, 1955, p. 666; for 1946-1955 from U. S. Department of Agriculture, *Crop Production*.

^b Bags of 100 lb.

We can sum up the shifts in production by saying that in a period of 90 years U. S. grain production has increased by an average annual rate of 1.5%, while the population increased at an annual rate of 1.7%. In 1866 a population of 36.5 million people had 38.8 million metric tons of grain production, or 1 ton per capita, while in 1956 this ratio had declined to eight-tenths of a ton.

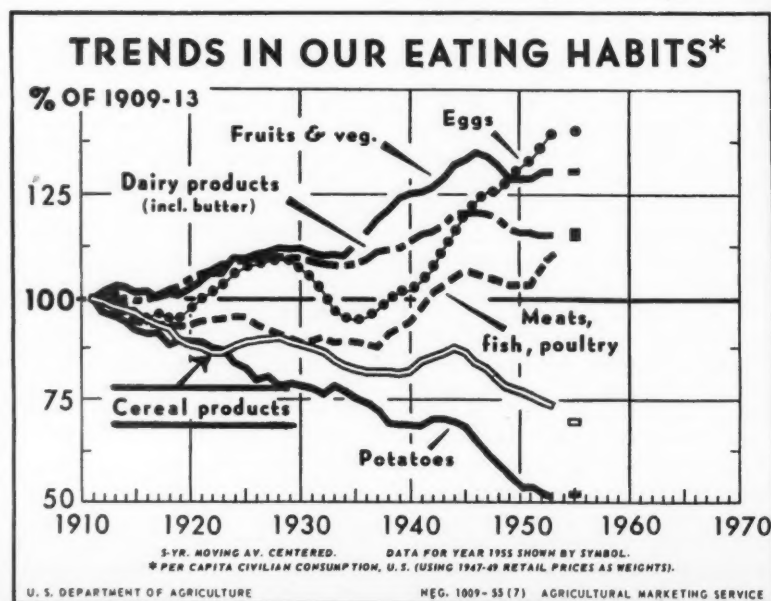
The Production-Consumption Enigma

This rough figuring seems to suggest a rather low rate of growth for grain production when we think of the need to improve the diet and to have greater abundance for all purposes including much heavier carry-overs. But this is deceptive; in fact, we have for years been bothered by excess grain production owing to a rapidly expanding potential capacity resulting from technological progress. The riddle will be solved later when we look into changes in utilization. But first let us glance at what has happened to consumption.

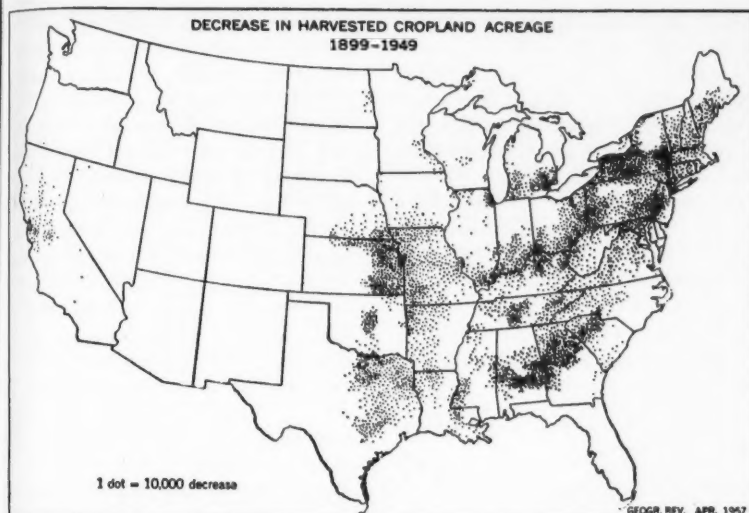
In the free market economy it is the consumer who allocates the nation's resources by voting with dollars and cents through his purchases. Thus he exercises his prerogative of satisfying his wants according to his preference. This he has done with remarkable tenacity and effectiveness with reference to the cereal economy, by changing his diet as economic de-

velopment created the need for it and gave him at the same time the rising purchasing power to exercise his changing preference.

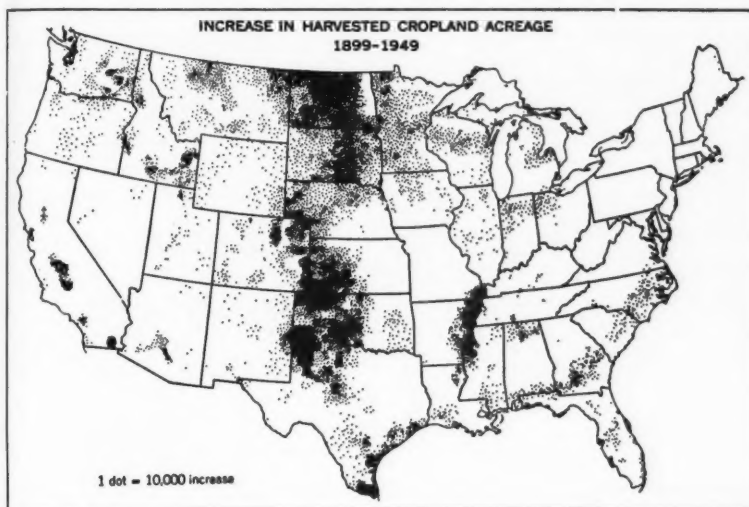
² Among the exceptions are the pastoral economies of parts of Argentina, of Uruguay, and New Zealand, as well as of the Eskimos.



Decline in consumption of cereal products.



Decrease (above) and increase (below) in cropland harvested, 1899-1949 (county unit basis). (From U.S. Census of Agriculture, 1950, Vol. 5, Part 4, 1952, p. 34.)

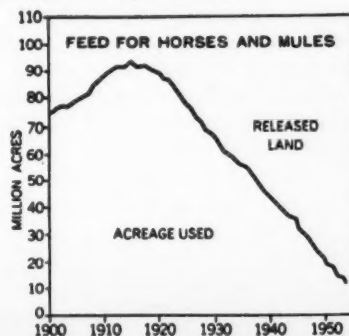


clined from 3,700 calories in 1879 to 3,200 in 1949-1951. The decline in the consumption of starch calories has been made up by calories from sugar and fats.

The so far unchecked shrinkage of direct human consumption of cereals has set an increasing amount of cereals free for other uses. But a similar downward trend set in 35 years ago and has prevailed ever since for the consumption of cereals by man's strongest competitor as a cereal eater—namely, horses and mules. The diet of these animals was not changed, although they were fed molasses and oilcake in addition to grain. After the culmination of its growth toward the end of World War I at a summit of over 25 million, the U. S. population of horses and mules has shrunk progressively until today

there are fewer than 3 million such animals, many of them on "old-age pension." Since each working horse consumes in a year about 3,500 to 4,500 pounds of grain, ten to twelve times as much as does a heavily bread-eating person, this elimination

Harvested acreage of crops used for feed for horses and mules, 1900-1954.



of cereals consumption as fuel for traction has helped to set free an additional vast amount for other uses. The total gain of grain set free for other uses amounts to over 20 million tons per year. In addition to this shift in the utilization of grain, a large acreage of land used for tame hay for horses was also set free for other uses, including production of grain.

Fortunately for grain-producing farmers, the change in the diet of the population still worked their way and in their favor. As people curtailed their consumption of starch calories, they increased their consumption of fats, a large part of which are produced by grain-consuming animals—first of all, dairy cows; second, hogs; third, chickens; and fourth, beef cattle. But the people also increased their consumption of meat, milk, and eggs.

The share of total calories consumed per capita in the form of animal products increased from 34% in 1879 to over 40% in 1949-1951. But from 1935-1939 up to 1956 the per-capita consumption of red meat increased from 127 to 167 pounds; of chicken meat from 13 to 24 pounds or by 31%; and of turkey from 2 to 6 pounds or by 200%.

This consumption shift was possible only because of the change in the utilization of the total available supply of grain. The main shift is one toward more and more conversion of grain through livestock into food consisting of animal products. But since, in this conversion, anywhere from 70 to 90% of the calories in the feed are lost in the process, this shift in use from direct consumption to consumption of animal products expands the capacity of the market for cereals with a heavy multiplier.

More Grain to the Feed Trough

The greatest and most consequential shift in the entire cereal economy of this country is the transfer of more and more grain to the feed trough. For agriculture in general the trend is toward more and more use of acreage through livestock. We have today (1956 data) a livestock herd worth 11 billion dollars, representing roughly 166 million grain-consuming animal units. In the drought years 1934-1936 the herd fell from 163 million grain-con-

suming animal units in 1922 to a low of 131 million. During World War II it increased to 193 million units. Its present level of 166 million is to be explained in its main part by the elimination of horses and mules. Hog numbers fluctuate violently in response to changes in corn supply and the demand for pork. But this livestock represents also 72 million roughage-consuming animal units, the roughage requirements of which are to a small extent also supplied by grain silage, small-grain straw, and corn stover.

From 1940 to 1947 the total amount of all feed consumed by all livestock ranged between 264 and 312 million tons of corn equivalent. It was composed (1942-1946) of 36% of grain, 7.4% of commercial by-products including mill feed, and 55% of pasture, hay, and silage (pasture, 34.1%; hay, 15.6%; silage and beet pulp, 2.5%, and stover, 2.7%).

The following table shows the great increase in the proportion of the supply for domestic use that has been fed to food-producing livestock.

1956) there has been a decisive upward trend in the available supply of grain and of oilcake and meal per animal unit, and in the production per animal.³ The grain supply per animal unit per year increased from 23.6 bushel to 33.6 bushels.⁴ The oilcake and meal supply increased from 45 to 107 pounds per animal unit. These figures demonstrate the overabundance of available feed materials. The production of eggs increased from 132 to 194 eggs per hen, and the production of milk from 4,468 to 5,954 pounds per year.

The Towering Poultry-Meat Industry

But behind these astounding figures lies an epic chapter of combined progress in animal husbandry, genetics, veterinary science, and animal nutrition and livestock management. Of this complex pattern of change and economic progress, I can sketch only a few of the salient features. While the average rate of feed conversion has changed little for all livestock over the last 30 years, the estimated national average feed consumption per pound of broiler

for cattle and calves (2.4). Pound of animal protein produced: broilers consume 34 feed units, turkeys 44, hogs 95, and calves 130. These feed requirements of broilers and turkeys are extremely low, and represent a great triumph in the technology of cereal conversion. The result is that broiler chicken and turkey meat cost less today than they did 20 years ago despite the general price rise of all other food and of feed. In May 1957 the average U. S. retail price of eviscerated, ready-to-cook broiler chicken is down to 48 cents per pound as compared with 59.3 in June 1950. In 1933, the now flourishing broiler-chicken industry did not exist. This year's production is estimated at 1,350,000,000 birds. Together with 410 million slaughtered farm chickens, this means 4,300,000,000 pounds of eviscerated chicken meat, or 24.7 pounds of chicken meat per civilian consumer per year. The production of turkeys has increased from 176 million pounds of eviscerated meat in 1929 to 1 billion pounds this year, or 6 pounds per person. It appears that

Table II. Change in Utilization of the Grain Crop in the United States, 1899-1903 to 1950-1952^a

Year	Supply	Seed and Shrinkage	Human Consumption	Horse and Mule Consumption	Fed to Food-Producing Livestock	Industrial Use	Net Exported
<i>In million metric tons</i>							
1899-1903	98	8	11	19	48	3	9
1919-23	118	9	13	24	64	2	10
1934-38	92	8	15	12	55	4	1
1950-52	138	10	15	6	93	6	11
<i>In percent of supply for domestic use</i>							
1899-1903		9	12	21	54	3	
1919-23		8	11	21	58	2	
1934-38		9	12	12	61	4	
1950-52		8	9	5	73	5	

^a Data adapted from H. B. Krohn, "Die Futter-Getreide Wirtschaft der Welt, 1900-1951." *Berichte über Landwirtschaft* (Hamburg, 1957, 165 Sonderheft), p. 134.

The main long-run shift during the last 35 years in the utilization of grain fed to animals has been the allocation to dairy cattle and poultry of grain set free by the decline in the number of horses and mules (3). The short-run allocation changes from year to year, particularly because of changing hog numbers. During most recent years a typical range of proportions within the feed balance sheet has been that, of the grain and by-products of grain fed to food-producing livestock, 43% goes to hogs, 23% to poultry, 20% to dairy cattle, 10% to beef cattle, and 4% to sheep.

During the last 20 years (1936-

produced has decreased from 4.2 to 3.0 pounds.

In experiments broilers have been produced at a conversion ratio of 2 pounds of feed per pound of broiler, but large-scale production today is already operating with ratios of 2.5-2.7 to 1. Today, for the country as a whole, broiler chickens use, per 100 pounds of meat and fat excluding bones, only an average of 674 feed units as compared with 819 for hogs, 885 for turkeys, and 2,186

³ The 20-year period begins with the aftermath of the drought years 1934 and 1936, and therefore shows perhaps more increase than if a 25-year period were being considered.

⁴ The actual utilization has increased less because the "supply" included carry-over which is inflated by price-support policies.

the proportion of all concentrates fed to livestock that is fed to poultry will exceed 25%.

Since the poultry-meat industry is the most progressive element in the entire grain economy, and its impact on agricultural income and the food economy is greater than is apparent, I should like to survey briefly the key features of this biological business of converting cereals into the finest animal proteins.

The industry consists of an extremely well-coordinated system of at least ten different specialized types of enterprise. The performance of each of them, plus additional

(Please turn to page 230)

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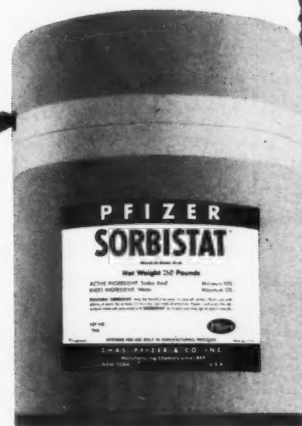


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EVALUATION OF FLOUR AND DOUGH PERFORMANCE AND BREAD QUALITY¹

SVEN HAGBERG, Head, Institution of Food Chemistry,
Statens Hantverksinstitut, Stockholm, Sweden

THE SUCCESSFUL OPERATION of a bakery or mill is predicted upon the use of reliable methods for testing flour and for predicting the performance of dough. It is essential that testing methods measure factors of primary significance in the baking processes and that the methods be rapid and simple. Many different factors influence the results, but the characteristics of major importance for performance of dough and bread quality are 1) the consistency of dough as related to its handling properties; 2) gas production, gas retention, and "firmness" of dough; and 3) bread crumb characteristics, especially the consistency of the crumb. Practical experience has shown that the quality of bread usually will be good if these characteristics are satisfactory.

Different methods have been suggested for the evaluation of dough consistency. Brabender (1) and Swanson and Working (9) have designed the farinograph and the mixograph, respectively, for the evaluation of dough characteristics during mixing. Jago (7), Stamberg and Bailey (8), Halton (6), and Hagberg (3) have designed simple apparatus for determining flour absorption according to the rate of extrusion of dough through an orifice. Hagberg (3) has shown that extrusion times are highly correlated with the proper water absorption of different flours, provided the temperature is controlled. These simple extrusion devices, however, are not generally used with success, apparently owing to lack of thermostatic control (3).

The determination of gas production and gas retention of doughs has been reviewed by Elion (2), Working and Swanson (10), and Hagberg (4). The same authors have designed apparatus for determining gas production as well as gas retention. The Hagberg Fermentometer also permits determination of the "firmness" of dough.

The major factor governing the consistency of bread crumb is the amylase activity of the flour. Hagberg (5) has reviewed the work on its determination.

The purpose of this paper is to describe methods for determining important flour characteristics required for proper dough performance and bread quality. Results obtained using these methods are discussed.

Testing Water-Absorption Capacity of Flour and Handling Properties of Dough

The water-absorption capacity of flour and the consistency of dough are important. A dough is considered to have the right consistency when after mixing and fermentation it is suitable for handling in the make-up

equipment. These handling properties of dough after fermentation may be different from those which exist before fermentation.

It usually is economical for the baker to use a flour with a high water-absorption capacity, because comparatively less flour is needed. A dough with the proper consistency usually produces bread of better quality than a stiff dough. Knowledge concerning the correct water absorption is also of great importance in testing doughs by physical methods.

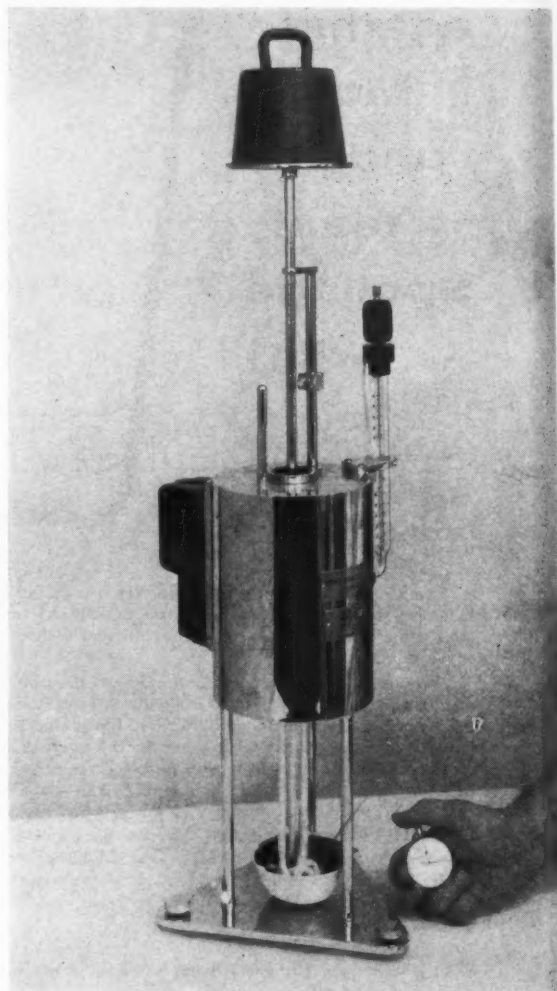


Fig. 1. Hagberg Consistometer (Mobilometer).

Investigations have shown that handling properties of dough, as well as water-absorption capacity of flour, can

¹ Manuscript received October 19, 1956.

be evaluated simply and rapidly by the extrusion time of dough in the Hagberg Consistometer (Fig. 1). The instrument consists of a metal cylinder and a plunger. The cylinder has a removable jet with holes at the bottom and is surrounded by a thermostat controlled to $\pm 0.1^\circ\text{C}$. To operate the device, a 150-g. portion of dough is introduced into the cylinder and the plunger is inserted. After the dough has rested for 3 minutes to equalize stresses and temperature, a 5-kg. weight is applied to the plunger and the extrusion time measured. The time in seconds required to extrude the dough is a measure of its consistency and handling properties. The consistency of the dough may be measured immediately after mixing as well as after fermentation in order to evaluate the change during fermentation.

Halton (6) found that a constant rate of extrusion could be used for assessing the water absorptions of different flours. Hagberg established this relationship using flours with a wide range of absorption (Table I). The consistometer has been used successfully for evaluation of water absorption of flours and handling properties of doughs.

TABLE I

EXTRUSION TIMES AT 25°C . FOR DOUGHS MADE WITH DIFFERENT FLOURS AND VARYING WIDELY IN ABSORPTION

FLOUR AND EXTRACTION	WATER ABSORPTION	EXTRUSION TIME
	%	seconds
Manitoba (0-40%)	64.2	17.5
	61.7	29.5 SS ^a
	59.8	45.9
Manitoba (40-70%)	63.1	16.5
	60.8	26.3 S
	58.7	43.6
Swedish summer wheat (40-70%)	60.7	14.7
	58.2	28.2 SB
	56.8	37.7
Swedish summer wheat (0-40%)	57.6	18.3
	55.7	23.9 SB
	53.9	38.5
Swedish winter wheat (40-70%)	56.2	17.3
	54.2	20.2 SB
	52.8	31.0
Swedish winter wheat (0-40%)	54.0	12.2
	52.0	18.2 SB
	50.0	25.3

^a Dough consistency: SS, slightly sticky; S, sticky; SB, suitable for baking.

Measuring Gas Production, Gas Retention, and "Firmness" of Doughs

The factors which govern the volume, grain, and texture of bread include gas production, gas retention, and "firmness" of dough. When these basic factors are measured it is essential that the testing methods employ conditions which correspond to those used in practice. The Hagberg Fermentometer has been constructed for determination of gas production, gas retention, and "firmness" of dough under usual commercial conditions.

The Hagberg Fermentometer, (Fig. 2) is a fermentation cabinet in which the desired temperature can be maintained by electrical heating and regulated by a contact-thermometer ($\pm 0.1^\circ\text{C}$). The fermentation "pans,"

in which the 150-g. pieces of dough are placed, are glass cylinders.

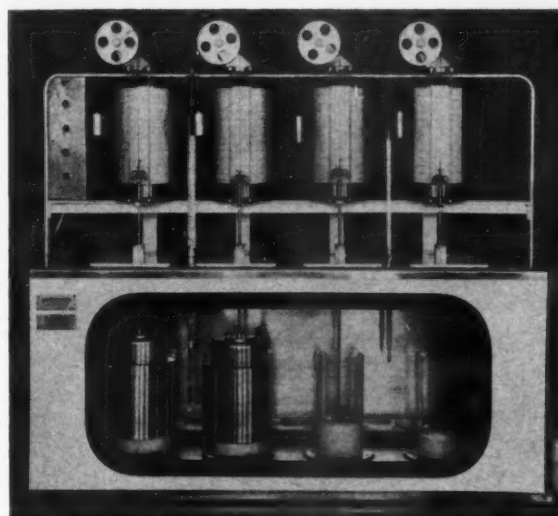


Fig. 2. Hagberg Fermentometer. The two devices to the left determine the gas production of the doughs; the two to the right, gas retention. All four devices can be used for determination of gas production or gas retention as well as "firmness" of dough.

When gas production is determined, a gas bell with an open tap is placed over a cylinder provided with a water-trap and containing the piece of dough. The tap is closed when the air pressure is balanced, and the gas produced during fermentation raises the counterbalanced gas bell, the movement being recorded automatically on a chart attached to an electrically driven kymograph. Gas retention is determined in a similar manner but, instead of the gas bell, a balanced perforated aluminum plate attached to a rod is employed. The movement of the plate, which rests on the dough, is recorded automatically. "Firmness" of the dough is determined in the same way as gas retention, except that the plate is loaded with a given weight.

Gas production of doughs made with different flours varies widely. Gas retention of dough often has great influence on the volume, grain, and texture of the bread; see Fig. 3 and the accompanying table.

It is also possible to evaluate with the Hagberg Fermentometer the influence of different ingredients on gas production and gas retention of dough (Fig. 4). Sodium chloride at the beginning of the proofing period improves gas retention more than potassium bromate, whereas the latter salt causes better gas retention than does sodium chloride at the close of the proofing period (Fig. 4.).

The different effects of sodium chloride and potassium bromate on gas retention led to the conclusion that, in addition to gas retention, some other significant factor must be considered (4). This factor is the "firmness" of dough. It is mainly responsible for differences in behavior of dough made with flour treated with bromate and a dough made with same flour which has not been treated. Gas retention and "firmness" values, determined at proofing of doughs made of the same flour with and without addi-

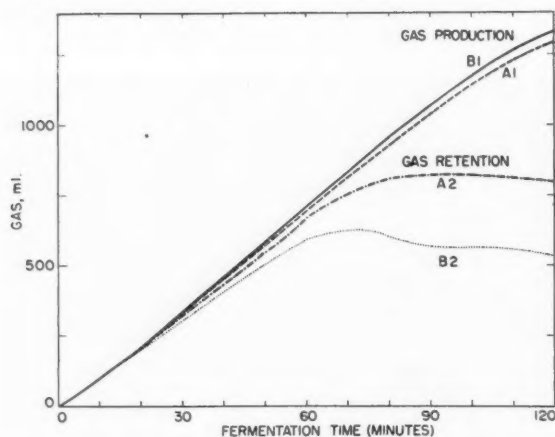


Fig. 3. Gas production and gas retention at proofing of doughs made of Manitoba wheat (A) flour and Swedish wheat flour (B). (Proofing started after 30 minutes' fermentation time.)

	Manitoba flour g.	Swedish flour g.
Composition of dough		
Flour	100	100
Water	60	50
Yeast	5	5
Sugar	5	5
Shortening	1	1
Salt	1	1
Temperature of dough (°C.)	30	30
Fermentation time at 30°C. (minutes)	30	30
Proofing temperature (°C.)	37	37
Bread volume (ml/100 g. flour) —maximum	780	520
Grain and texture of bread	Excellent	Not satisfactory

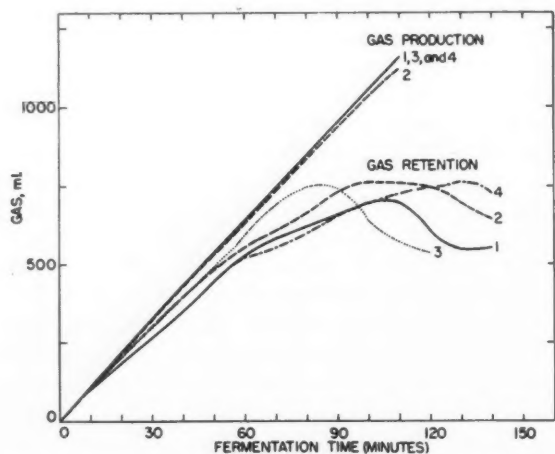


Fig. 4. Influence of sodium chloride, potassium bromate, and shortening on gas retention during proofing (at 37° C.) of doughs made with the same flour plus water, yeast, and sugar, with the following additions: curve 1, no addition; curve 2, 1% sodium chloride; curve 3, 1% shortening; curve 4, 0.004% potassium bromate.

tion of sodium chloride or potassium bromate, are shown in Fig. 5. Practical experience has shown the importance of evaluating gas production as well as gas retention and "firmness" of dough.

Relation of Amylase Activity to Bread-Crumb Properties

The amylolytic activity of flour influences gas produc-

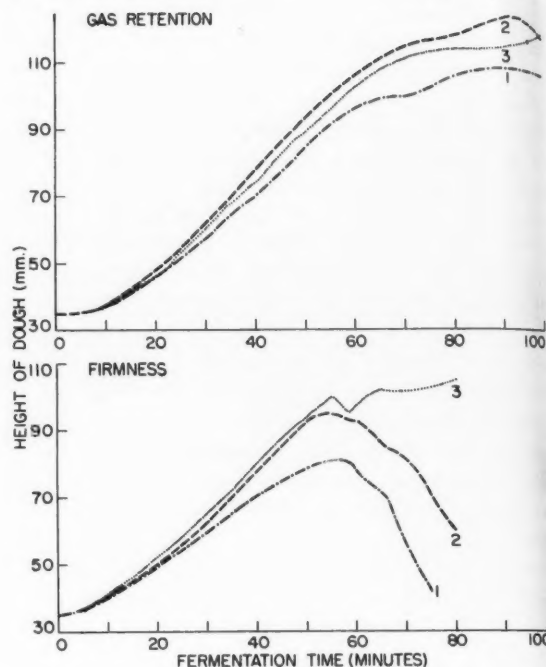


Fig. 5. Influence of sodium chloride and potassium bromate on gas retention and "firmness" during proofing of doughs made with the same flour plus water and yeast, with additions as follows: curve 1, no addition; curve 2, 0.5% sodium chloride; curve 3, 0.005% potassium bromate.

tion, gas retention, and "firmness" of dough, and bread-crumb properties. The major factors influencing bread-crumb characteristics are the amount and properties of the gelatinized starch which has not been liquefied by alpha-amylase (5). The amount and properties of the protein and other substances also influence the characteristics of the bread crumb.

If enzymic action (mainly alpha-amylase) is insufficient, the crumb will be dry and harsh. If the enzymic action is excessive the crumb will be too soft, gummy, and sticky because too much of the starch has been partially hydrolyzed. To obtain a sufficiently soft and moist bread crumb it is, therefore, very important that testing methods are such as to ensure the correct degree of enzyme action in the dough.

The author has employed several different methods to test the "diastatic state" of flours and doughs (5). Bread crumb has plastic and elastic, rather than viscous, properties. To get testing values which agree closely with actual bread-crumb properties, it was found advisable to simulate more closely the conditions which prevail during practical baking. For that reason a method for measuring the consistency of gelatinized concentrated flour pastes or doughs was investigated (5). The mixture of flour and water is placed in a stainless-steel beaker and heated in a boiling-water bath (Fig. 6) under controlled temperature conditions. After cooling, the consistency of the mass is determined by means of a specially constructed penetrometer (Fig. 7). The depth in millimeters to which the cone sinks in the gelatinized

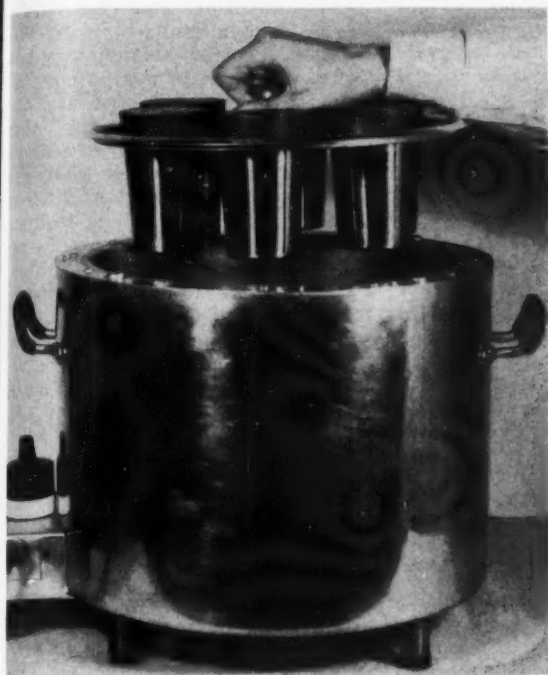
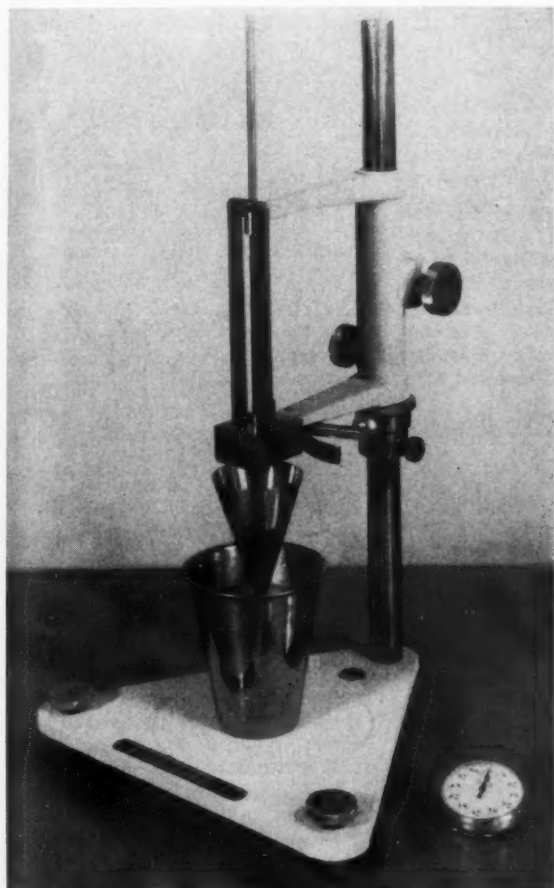


Fig. 6. Water bath with beakers for gelatinization.

Fig. 7. Penetrometer for determination of diastatic state.



paste during 10 seconds is recorded as the "diastatic state figure." A good wheat flour with correct enzyme action should give a firm jelly (Fig. 8, left) and a medium penetration figure (20–30 mm.). A flour with excessive enzymic action should produce a more or less viscous fluid (Fig. 8, right) and a high penetration figure 50–60 mm.).



Fig. 8. Results with different flours using the apparatus shown in Figs. 6 and 7. Left, flour with normal enzyme action; right, flour with excessive enzyme action.

If the diastatic state figure is low (5–15mm.), the crumb will be dry and harsh and the dough will not ferment properly. The purpose of cooling the gelatinized paste is to evaluate the influence of retrogradation. For rapid determination of enzymic activity, cooling may be omitted.

Practical experience in bakeries over many years has shown that the method described gives values which are in good agreement with actual crumb characteristics and which also are of significance for gas production in dough.

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People, (Products), Patter

• • • People

New appointments at A. E. Staley Mfg. Co. research division, Decatur, Ill., are **William R. Armstrong**, **Harold D. Allen**, **Ogden C. Johnson**, and **Harold R. Ready**. **Leonard F. Barrington** named leader of Staley's newly created research group in industrial products development at Decatur.

Walter T. Blake leaves Pillsbury Mills, Inc., where he was manager of research and development, to become vice-president and general manager of C. W. Brabender Instruments, Inc., South Hackensack, N. J.



Rowland J. Clark of the W. E. Long Co., Chicago (center, above), was given a Lifetime Membership Award in the Pioneer Section, AACC, at the Section meeting in Wichita, August 17. **John Giertz**, left, of Kansas Milling Co., Wichita, made the presentation. At right is **Lyle P. Carmony**, Sterwin Chemicals, Inc., Minneapolis, Pioneer Section chairman.

James F. Conn leaves International Milling Co. to join research department of Monsanto Chemical's inorganic chemicals division, St. Louis, Mo.

Henry L. Cox, specialist in food technology, named a technical consultant at Armour Research Foundation.

John J. Halsey leaves Merck & Co. to join General Foods Corp. as manager of quality services.

William Herbst named supervisor of starch applications research at National Starch Products, Plainfield, N. J. **Irving Martin** named senior chemist.

Ray Hert and **K. Hlynka** are among Continental Baking Co. lab staff who have relocated their homes because of the company's move from New York City to Rye, N. Y., the former to White Plains, N. Y., and the latter to Georgetown, Conn.

David H. Knutson joins products research staff, and **Werner Motzel** the research and development staff, of Procter & Gamble's food products division.

John W. Lee, upon receiving his Ph.D. degree at the University of Minnesota, returns to Dairy Research Section of Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, with a 3-month stopover at British Baking Industries Research Association, Chorleywood, Herts., England. Dr. Lee's work at Minnesota concerned liquid ferments.

William Nelson appointed sales manager of H. Kohnstamm & Co's. western division, Chicago. He also continues as assistant secretary.

O. A. Oudal appointed director of products control for General Mills, Inc., from management of products control, grocery products division. **Frank C. Hildebrand**, vp and former director of products control, assigned new responsibilities for organization planning.

Frederick D. Thayer, Jr., from Mead Corp., joins research and development departments of Corn Products Refining Co. as research chemist.

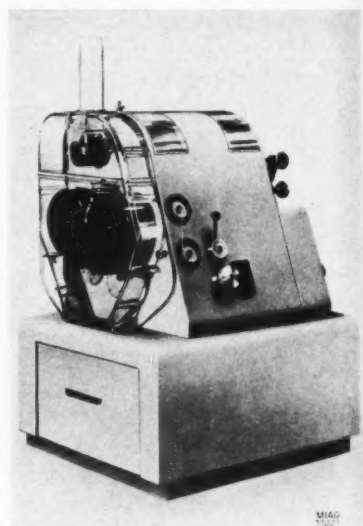
• • • Products

Brewers' and maltsters' equipment to be exhibited by Thos. Robinson & Son Ltd., Rochdale, England, milling engineers, at the Brewers' and Allied Traders' Exhibition, London, Sept. 30 to Oct. 4, will include a mobile malt turner. This is designed to save time and cut labor costs without the considerable capital outlay normally required for complete mechanization. The malt is turned by an eight-bladed rotor driven at 260 r.p.m.,

through reduction gearing, by a 1/2-h.p. electric motor. The machine is of light but robust construction and is transported from piece to piece, or floor to floor, simply by turning it over onto rubber-faced castors mounted on the main frame. It is said to reduce by about 50% the time required to turn a floor to ensure more thorough aeration, a piece turned by the machine being left noticeably deeper than if turned by hand. Further, the turner is claimed to be incapable of damaging the grain.

Other equipment to be shown includes examples of the wide variety of components incorporated in the Robinson Pneu-Spout gravity conveying system, which is designed to be flexible, and easily erected and dismantled; and of automatic electric weighing and remote-reading electrical temperature equipment.

The Vario Roll Stand (see cut), just introduced by Miag North-America, Inc., Minneapolis, is an experimental machine for testing the grinding behavior of grain and other granular products—the grinding behavior being largely influenced by the preceding conditioning process. Novelty features



are "open-end rolls (9- or 10-in. diameter, 4-in. length) permitting close observation of the process in the grinding zone between the rolls; quick and easy exchange of rolls for experimentation with different material, surfaces, and/or corrugations of rolls; and variable speed of grinding and feed rolls as well as variable differential speed. Plexiglass covers on rolls and discharge allow movie camera equipment to be attached.

Calcium and sodium propionate, widely used rope and mold inhibitors in the baking industry, are now being marketed by Eastman Chemical Products, Inc., subsidiary of Eastman Kodak Co. The propionates, packed in 150-lb. drums, are stocked in New York, Chicago, Houston, Kingsport, Tenn., Los Angeles, and San Francisco. Technical assistance for users will be available through food service laboratories at Kingsport, Tenn. Other possible applications include inhibiting functions in food packaging materials and dairy products.

A new Eastman brochure entitled "Analysis of Phenolic Antioxidants" describes the extraction of antioxidants from a variety of foods, feeds, and packaging materials, qualitative tests for the presence of antioxidants, preparations of standard concentration curves and spectrophotometric quantitative tests, plus a discussion on the reproducibility of these test methods. The three phenolic antioxidants covered in the text, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), and propyl gallate, are marketed under the trade name, Tenox. For copies of the brochure and/or information on the propionates, write Eastman Chemical Products Inc., Kingsport, Tenn.

Air Separators and their use in closed-circuit grinding, Micronizer fluid energy mills grinding, and Rotary Batch Blenders are described in an 8-page 1957 Dry Processing Equipment Catalog (Sturtevant Mill Co., Boston 22, Mass.). Information is also given on crushing and grinding machines, fertilizer machinery (mixers, granulators, screens, elevators, and conveyors, etc.), and laboratory reduction mills.

Sprout-Waldron's Customix Cold Molasses Feed Mixing Unit, a high-speed mixer for adding cold molasses into premixed feed, has been modernized with a new agitator, new-type bagging discharge, and other features. Capacity is 3 to 6 tons per hour of quality feeds. The unit mixes the molasses into the feed, not just on it. Bulletin 98-A describes it. Sprout, Waldron & Co., Inc., Muncy, Pa.

Beckman Bulletin No. 19 is a "parcel of informative news and pictures," featuring stories on laboratory instrumentation. It tells about two new products, the Zero-

matic and Pocket pH Meters, and new accessories such as reflectance unit and fluorescence attachment. "Infrared Notes" describe the infrared spectrophotometers. Bulletin 86L describes Beckman pH electrodes. Write Scientific Instruments Division, Beckman Instruments, Inc., Fullerton, Calif.

Another Beckman release announces the AC Power Supply Unit, an accessory to the Beckman DU Spectrophotometer. The unit is a complete power source, adaptable to DU Spectrophotometers and accessory combinations now in use. It eliminates the need for standard storage battery and dry cells and replaces the ultraviolet power supply. For information write to the address above.

Shadograph Scales, designed for use in the food processing industry, are described in a brochure containing illustrations, detailed specifications, and important features of 34 models, from 2000 MG to 100 pounds capacity. Write for Form 3333, Exact Weight Scale Co., Columbus, Ohio.

Mercurial barometers and vacuum gages, vacuum pump gages, and absolute pressure gages are described in Bulletin D-2, Precision Thermometer and Instrument Co., 1434 Brandywine St., Philadelphia 30, Pa.

• • • Patter

Continental Baking Co. has moved its national headquarters from Rockefeller Plaza in New York City to a new location in Rye and Harrison, Westchester County, N. Y. The new plant consists of a two-story general office building and connecting research laboratories. A company kitchen and a dining room seating about 200, together with an outdoor terrace, game room, and recreational lounge contribute to employees' convenience and satisfaction.

Features of the research laboratory are a pilot bakery, home economics test kitchen, and a "weather room" with controlled temperatures for testing products prior to storage. For special research projects there are five rooms; two of these are for testing frozen products.

A news release of a sort that is fortunately rare comes from Kansas State College, Manhattan, where a disastrous fire on August 25 destroyed the pilot flour milling fa-

cilities and a large part of the east wing of Waters Hall in which the Flour and Feed Milling Industries Department was housed. Several laboratories and their equipment, including the USDA hard winter wheat lab, were completely destroyed. Offices of staff and faculty were badly damaged or destroyed.

The Kansas Crop Improvement Association and a number of offices of the Agronomy Department, in addition to the Milling Department's facilities, were housed in this wing of Waters Hall, main building of the K-State School of Agriculture. The new central wing and the recently added feed milling wing were relatively undamaged, but only the limestone walls stand where the pilot mill once operated. Value of the flour milling facilities was placed by J. A. Shellenberger, head of the Milling Department, at \$300,000. Total loss has not been estimated as salvage operations and investigations continue.

Dr. Shellenberger is arranging to continue the milling technology curriculum, offering all subjects and depending heavily on field trips to provide experience for students. "We plan to carry on, doing the best we can," he said. Dr. Shellenberger is grateful for the many expressions of concern, to which he cannot make a personal reply at this time.

A different mechanical approach to the problem of distributing substances across to immiscible liquid phases, the analytical technique of column partition chromatography, is outlined in a booklet available from Merck laboratory chemical distributors.

Title is "Column partition chromatography" (16 pages).

"Pound for pound, soy flour contains about twice as much protein as meat, four times as much as eggs, and 12 times as much as milk," says a new booklet published by Archer-Daniels-Midland Co. Soy flour also improves foods, especially bakery goods, in various ways, continues the book; it retards staling, and gives finer texture, richer colors, and more tender crusts. A number of institutions, it says, are turning to soy flour as an economical source of proteins and to raise dietary standards. Archer-Daniels-Midland Co., 700 Investors Bldg., Minneapolis 2, Minn., will send a copy or copies.

Significant changes in the formula feed business the past two years or so, particularly in the composition of poultry feeds, may well have a far-reaching effect upon the demand for and price of millfeeds. The formulas for these high-energy feeds run heavily toward carbohydrates such as corn, and high-protein meals such as soybean meal, reducing significantly the percentage of millfeeds used in many feed formulas.

• • •

Sesame seed should offer little difficulty in processing by the filtration-extraction method, according to results of bench-scale experiments carried out at the Southern Utilization Research and Development Division, ARS. The studies were undertaken to establish the best conditions of preparation and extraction, and it is believed that the results of the bench-scale trials can be considered a reliable basis for commercial operations on sesame.

Conditions recommended for preparation of the seed for extraction, and details of the experiments, are reported in the *Journal of the American Oil Chemists' Society* for December 1956. Single reprints of the article, entitled "Filtration-extraction of sesame seed on a bench scale," are offered without charge by the Division, 1100 Robert E. Lee Blvd., New Orleans 19, La.

• • •

The 26th Exposition of Chemical Industries will be staged in the New York Coliseum during the week of December 2-6. With the chemical process industries representing a multibillion-dollar market now and a still brighter future indicated, exhibits of chemical products and chemical process equipment will undoubtedly exceed any and all in the exposition's 42 years. The industry's constant search for new processes, more efficient techniques, and improved product performance will be reflected in the theme of the exhibits: "Increase production—cut costs!" Thirty-five to forty thousand visitors are anticipated. Awaiting them is a comprehensive post-graduate course in new developments and recent innovations. The exposition is managed by E. K. Stevens, president of the International Exposition Company.

PAGE 230 • CEREAL SCIENCE TODAY

Dynamic Shifts:

(Continued from page 222)

services by others, are prerequisites for the success of broiler production. It is a mistake to speak of vertical integration, although there is a certain amount of this in existence. The branches of the industry, in the main, operate as free and independent agents in a free market with intensive competition at all levels and over the entire area of the United States. The enterprises to which I refer are the following:

1. Breeders of purebred strains of various types of meat chickens to be used as hens and as cocks for fertilized hybrid eggs.
2. Producers of hybrid brooding eggs.
3. Incubators who buy brooding eggs and sell baby chicks to broiler producers as well as to turkey producers and egg producers. They produce and sell baby chicks on order for broiler producers, vaccinate and "sex" the chicks, i.e., separate pullets from cockerels.
4. Feed mills and mixing plants which produce formula feeds with vitamins, minerals, guaranteed protein, content, antibiotics, and other medications.
5. Research stations which develop new formulas, study nutrition and veterinary-medicine problems concerning chickens, and constantly test the output of the feed mills.
6. Feed dealers who supply the broiler producers.
7. Broiler producers, usually with capacities of from 10,000 to 40,000 broilers per man and a fourfold output per year with a 10- to 11-week production cycle.
8. Poultry slaughterers and processors with sufficient capacity to absorb the output of the producers.
9. Poultry-meat wholesalers.
10. Poultry-meat retailers.

This industry needs the services of rapid, long-distance refrigerator truckers, as well as the products of the pharmaceutical industry.

The heart of the whole broiler industry is the feed mills, which move

the vast amounts of mixed cereal feeds to the broiler-producer plants. Today the California broiler industry is under severe competition in its own local market from Georgia, Arkansas, and other distant areas which send their products in 10-ton trucks to the West Coast.

With this brief glance at the new industry which produces in 10 weeks from hatch to slaughter 3½-pound meat birds—1.3 billion of them in one year—I shall conclude my remarks.

A Look at the Future

The cereal economy of this country not only has a golden base but an even greater future. It participates to the fullest extent in the rapid technological progress that is responsible for the rising wealth of this country. The cereal economy will become increasingly identified with the livestock-feed industry for which it supplies about half the feed requirements. The grain economy suffers from excess capacity of our farms to produce and from exorbitant surpluses in public granaries that are a nuisance to us and other countries, and have been created chiefly by price-support measures which cause the lag in their disappearance into consumption. The surplus situation is already approaching the markets for livestock products, particularly, at the moment, the broiler market.

Chemistry has a vast area for further experimentation with and improvement in conversion efficiency in the hog and cattle industries. The broiler industry has shown the way.

From my studies in the area of agricultural and food economics I derive over-all *stratagem Number One* for all efforts toward improving a nation's nutrition: *create abundance of starchy staples!* These may be grains, plantains, starchy tubers, or roots. If, when and where this is achieved, all other problems of supplying enough proteins and fats will become manageable.

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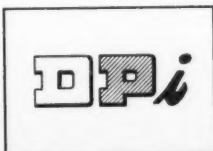


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OVERSEAS REPORTS



• • • England

The following is a short account of a symposium on "Flour and Bread" held by the Nutrition Society at Cambridge University, July 5 and 6. A full report will appear in Vol. 17, No. 1 of the *Proceedings* of the Nutrition Society.

Dame Harriette Chick summarized the fascinating history of wheat cultivation and breadmaking from antiquity onwards. Earlier scientific work on flour, she said, dealt with chemical and physical properties of its proteins, particularly of the gluten because of its importance in baking technology. From the middle of the last century, however, the nutritive value of the different parts of the grain has been studied. Dame Harriette praised the work of Rubner and of Girard (1833-1884), particularly in showing the high protein content of the aleurone layer. Later workers have shown that 80 to 90% of this protein is available to human subjects. The proteins in wheat bran are richer than those of white flour in two of the essential amino acids, lysine and tryptophan.

C. R. Jones used a simplified flow-sheet to explain the essentials of the flour-milling process, and discussed differences in nutrient content between the various flour streams that together form straight-run flour. The compositions of these streams at different extraction rates were shown. Vitamin B₁, in particular, is largely contained in a small proportion of the total flour from the end of the milling system, which incidentally is a poor breadmaking quality. Data were given to show that, even at a given extraction rate, the "natural" content of nutrients in straight-run flour may vary considerably.

Miss E. M. Widdowson considered some of the factors affecting the planning of human nutritional experiments. Particular difficulties encountered in the celebrated German experiments included the overcoming of a belief by those in charge of one home that it was morally wrong to allow children to eat *ad lib*.

Neil Jenkins, referring to the lack of evidence in support of the belief that high carbohydrate consumption promotes dental decay, and the associated view that brown bread is better than white in this respect, offered the following two suggestions. Flour or bread texture may be important; the extent to which food debris adheres to teeth is less after eating brown than after eating white bread. He also recalled T. B. Osborne's postulate that bran contains a factor that hinders attack on teeth by acids. Jenkins suggested this may be a phytate.

R. A. Morton gave an account of the considerations and conclusions of the Cohen Panel on Composition and Nutritive Value of Flour, of which he was a member. While the adoption of an 80% flour, he said, might conceivably ensure against possible but as yet unknown

shortages in the diet, enrichment of white flour would give more positive protection against clearly defined deficiency states.

H. M. Sinclair discussed the question whether, nutritionally, enriched 70% is equivalent to high-extraction flour. A table showed that the contents of pyridoxin, biotin, folic acid, linoleic acid, and vitamin E (alpha-tocopherol) were all materially lower in the white flour; of pantothenic acid there was no appreciable difference. In Dr. Sinclair's opinion, pyridoxin, linoleic acid, and vitamin E have been grossly neglected and are very important in human nutrition. High-extraction flour is the most important single source of pyridoxin; a decreased extraction rate reduces intake seriously.

Dr. Sinclair tentatively estimates the contents of linoleic acid in 80% and in 72% flour as 0.8% and 0.5% respectively. Normally it is protected, both from atmospheric oxidation and during body metabolism, by its accompanying vitamin E. The consideration may therefore be important that not only is vitamin E present initially to a smaller extent in white flour, but it is destroyed by bleaching. Moreover, bleaching may not only destroy the essential fatty acid (EFA) activity of the linoleic acid in flour but may convert this substance into an antagonist that might increase the EFA requirement. EFA deficiency might arise from dietary deficiencies in respect of linoleic acid, or of pyridoxin, or of vitamin E, since these are functionally interrelated, and it may be relevant to a variety of diseases of civilization, including coronary thrombosis and dental caries.

D. W. Kent-Jones, in presenting "The case for fortified white flour," stressed the importance of the preference of the British public for white bread as against even the slightly darker 80% extraction flour. The levels of fortification originally suggested by the Postwar Loaf Conference are now under reexamination by the Food Standards Committee, who are also considering whether flour should be fortified with riboflavin.

J. R. Nicholls and J. R. Frazer discussed analytical problems in the determination and control of extraction rates of flour, and reviewed various chemical constituents of flour and wheat, showing that none is strictly applicable to the determination of extraction rate. There is, however, a particular interest attached to the determination of starch, since this is provided partially entirely by the endosperm while other carbohydrates are distributed to varying extents throughout the grain. The starch content of the endosperm is affected by the protein content, which varies considerably between wheats, but the ratio of nonstarch carbohydrate to the sum of starch plus protein was offered as an approximate index of flour grade. Values for this index appeared characteristically dependent on extraction rate and fairly independent of type of grist.

E. Kodicek emphasized that a proportion of nicotinic acid in cereals is in the bound form and unavailable to a number of animals. On the other hand, nicotinic acid added by way of enrichment is wholly available.

C. R. JONES
Corresponding Editor

A.A.C.C.

LOCAL SECTIONS

Members and guests of Lone Star Section enjoyed a week-end meeting along with recreation at Lake Murray Lodge, Ardmore, Oklahoma, on September 6 and 7. The ladies' program was handled by Mrs. A. A. Rolfe. Speakers included A. M. Schlehuber of Oklahoma State University, Stillwater, who discussed "Common fallacies concerning wheat"; Ed Vaupel, Technical Director, Food Industries, Dallas, who gave "Some observations on fungal enzymes in baking"; and Arnold Kaehler, Special Foods Co., Red Wing, Minn., whose subject was "V-10 bread." Proceedings were brought to a delightful close with a dinner-dance.

Pacific Northwest Section's August Newsletter tells about a new variety of Montana wheat called Itana, running 13.3% protein according to Mark A. Barmore's test of a sample. It is a Blackhull-Rex X Cheyenne cross which has been under test for several years and appears to be quite satisfactory as a hard red winter, bread-type variety. Dr. Barmore believes its recommendation in Washington will be considered this coming year, the Newsletter says. Samples were offered for preliminary tests, obtainable from Dr. Barmore up to September 15. Some may still be available if requested immediately.

The Section welcomes a new member, Mr. Harlan Dobas, Interior Warehouse Co., Portland, Ore.

First meeting of Northwest Section this season was held at noon on September 27 in Dayton's Sky Room, Minneapolis. Hermann Schlenk of the Hormel Foundation, Austin, Minnesota, discussed lipids and some recent advances in methods for their identification and analysis, especially of mono-, di-, and triglycerides.

Kansas City Section's regular meeting on September 9 at Hotel President was preceded by an informal dinner in the hotel's Coffee Shop. The meeting featured two guest speakers: Glenn E. Hargrave of The Panipus Co., who explained "The role of a bakery serviceman," and John A. Johnson, Kansas State College, who spoke on "Chemistry of pre-ferments."

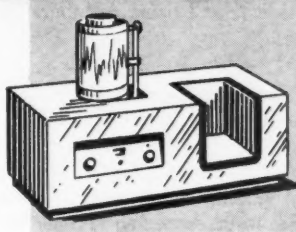
Nebraska Section enjoyed its annual picnic on August 25 at Capitol Beach, Lincoln. The Schaffer Trophy for outstanding analyses was awarded to Robert R. Pruckler, of Nebraska Consolidated Mills, Inc., Grand Island. At the next meeting, on September 28 in Omaha, a Crop Panel will be directed by Howard Becker of Nebraska Consolidated Mills, Inc., Omaha.

A Tri-Section meeting will be held on October 11 and 12 in Manhattan, Kansas, beginning Friday evening with smorgasbord at the Wareham Hotel; M. H. Thornton of Midwest Research Institute, Kansas City, Mo., will speak on "How management looks at research."

Saturday's program at Willard Hall, Kansas State College, promises a stimulating bill-of-fare. Subjects and



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speakers will be: "Infra-red patterns of wheat gluten"—Basil Curnutte; "Trends in physical dough testing"—S. J. Loska; "Sponge vs. straight dough baking methods"—R. M. Sandstedt; and "Bread—for man or rats"—W. B. Bradley. At the noon luncheon Dr. Bradley, in his capacity as National AACC President, will bring members up to date on association affairs.

Postscript from Pioneer Section's meeting, August 16 and 17, in Wichita: Jeff Schlesinger, for his X-ray Committee, stressed the importance of proper exposure and processing of films and care in even placing of kernels in the tray. Identification of kernel damage shown on the film is more certain, he said, when suspected kernels are cut open and given further scrutiny.

Howard Becker reported some good protein in eastern Nebraska wheat this year, with low protein in the west, and an average of 11.25% from 7000 cars at Omaha. F. D. Schmaltz said proteins in the Dakotas are a little different from last year's and that Montana has higher protein; mixing curves on spring wheat are a little longer this year, and low ash trends in the winter wheat region failed to reach the north.

Discussing the wheat variety situation in Kansas, C. W. Pence urged that varieties be developed to be resistant to soil-borne mosaic, which differs from streak mosaic in that it will remain forever in the soil.

Progress in aeration and fumigation of elevator bins was reviewed by J. O. Hibbard. Wheat bins as tall as 150 feet and 30 feet in diameter have been successfully aerated and fumigated, he said.

New members welcomed are Richard Gartner, Beardstown Mills Co., Beardstown, Ill.; R. E. Huschle, Valier & Spies Milling Co., St. Louis; Dale R. Reding, Victor Chemical, Kansas City, Mo.; Paul W. Waldvogel, Merriam, Kans.; and Harold Hartley, Hunter Milling Co., Wellington, Kans.

Next meeting, December 6 and 7, at Baker Hotel, Hutchinson, Kansas.

LOCAL SECTION OFFICERS

Northwest Section, No. 1

Chairman: R. A. LARSEN, Pillsbury Mills Research Laboratory, Minneapolis, Minn.

Vice Chairman: HARRY G. OBERMEYER, General Mills Research Laboratory, 2010 East Hennepin, Minneapolis, Minn.

Secretary: ROBERT PICKENPACK, General Mills, Inc., General Mills Bldg., Minneapolis, Minn.

Meeting place: Minneapolis, Minn.

Meeting date: Last Friday of each month

Pioneer Section, No. 2

Chairman: LYLE P. CARMONY, 533 Metropolitan Building, Minneapolis, Minn.

Vice Chairman: CLAUDE NEILL, Box 407, Enid, Okla.

Secretary-Treasurer: WAYNE PARKER, General Mills, Inc., Wichita, Kan.

Meeting place: Wichita, Kansas, and Enid, Okla.

Meeting date: Regularly in April, August and December; Tri-State at Manhattan, Kansas, in October and joint meeting with K.C. Section in February

Kansas City Section, No. 3

Chairman: DEAN NUNN, Sterwin Chemical Co., 1517 Walnut, Kansas City, Mo.

Vice Chairman: JOHN E. LAWLER, The Panipulus Co., 2533 Southwest Blvd., Kansas City, Mo.

Secretary-Treasurer: BOYCE DAUGHERTY, Commander-Larabee Manufacturing Co., 1701 Armour Rd., North Kansas City, Mo.

Meeting place: Kansas City, Mo.

Meeting date: Second Wednesday of each month

Nebraska Section, No. 4

Chairman: PAUL J. MATTERN, Dept. of Biochemistry & Nutrition, College of Agriculture, University of Nebraska, Lincoln, Nebr.

Vice Chairman: HOWARD C. BECKER, Nebraska Consolidated Mills Co., 1521 N. 16th St., Omaha, Nebr.

Secretary-Treasurer: REX N. RUCKSDASHEL, Lexington Mill & Elevator Co., Lexington, Nebr.

Meeting place: Not regular

Meeting date: Third Saturday of each month

Central States Section, No. 5

Chairman: HERMAN SAUSSELLE, Anheuser-Busch, St. Louis, Mo.

Vice Chairman: R. G. KOHLER, Merck & Co., Inc., Rahway, N. J.

Secretary-Treasurer: Both positions open. HERMAN SAUSSELLE acting Sec.-Treas. until nominating committee fulfills its obligations.

Meeting place: Not regular

Meeting date: Third Friday of each month

Niagara Frontier Section, No. 6

Chairman: ANN COLLINS, Best Foods, Buffalo, N. Y.

Vice Chairman: CLAYTON SCHNEIDER, Henry & Henry, Buffalo, N. Y.

Secretary: JACK MONIER, General Mills, Inc., Buffalo, N. Y.

Treasurer: ROBERT VAN BUREK, Wallace & Tiernan, Buffalo, N. Y.

Meeting place: Buffalo, N. Y.

Meeting date: Second Monday of each month

Pacific Northwest, No. 7

Chairman: JACK E. MILLER, Terminal Flour Mills, Terminal No. 4, Portland, Ore.

Vice Chairman: BLYNN SPEAKER, Helix, Ore.

Secretary-Treasurer: DOYLE UDY, Western Wheat Quality Lab., Ag. Experimental Station, Pullman, Wash.

Meeting place: Different location each year

Meeting date: June, 1958, Annual two-day meeting, Spokane, Wash.

Midwest Section, No. 8

Chairman: CHARLES S. McWILLIAMS, American Institute of Baking, Chicago, Ill.

Vice Chairman: ROBERT B. KOCH, Quartermaster Food & Container Inst., Chicago, Ill.

Secretary-Treasurer: EDWARD I. FEIGON, Kitchen Art Foods, Inc., 2320 N. Damen Ave., Chicago, Ill.

Meeting place: Chicago, Ill.

Meeting date: First Mondays, October through May

New York Section, No. 9

Chairman: DONALD DAVIS, Continental Baking Co., New York, N. Y.

Vice Chairman: OTTO JENSEN, National Biscuit Co., New York, N. Y.

Secretary: BUD EDELMANN, Great A & P Tea Co., New York, N. Y.

Meeting Place: New York, N. Y.

Meeting date: Second Tuesday, October through May

Lone Star Section, No. 10

Chairman: E. G. VICKERS, Alva Roller Mills, Alva, Okla.

Vice Chairman: A. A. ROLFE, Quaker Oats Co., Sherman, Okla.

Secretary-Treasurer: WALTER J. RUDY, Merck & Co., Inc., 7713 Inwood Road, Dallas 9, Tex.

Meeting place: Not regular

Meeting date: Spring, summer, and fall

Toronto Section, No. 11

Chairman: C. WEBSTER, Merck & Co., Toronto, Ontario

Vice Chairman: TOM SNOWDEN, Monarch Dairies, Toronto, Ontario

Secretary: GEORGE W. SMILEY, Maple Leaf Mills, Toronto, Ontario

Treasurer: HUGH KEEPING, Charles Albert Smith Ltd., Toronto, Ontario

Meeting place: Toronto, Ontario

Meeting date: Third Friday of month; Sept. to April

Cincinnati Section, No. 12

Chairman: JAMES S. KELLY, Lyon & Greenleaf Co., Inc., P. O. Box 31, Ligonier, Ind.

Vice Chairman: CLYDE J. STEELE, Gaines Division, General Foods Corp., Kankakee, Ill.

Secretary-Treasurer: LELAND S. THOMSON, Strietmann Biscuit Co., Cincinnati 27, Ohio

Meeting place: Not regular

Meeting date: No fixed date. Usually meetings are held in September, January, May

Canadian Prairie Section, No. 14

Chairman: E. J. BASS, Grain Research Lab., Winnipeg, Manitoba

Vice Chairman: L. R. JOHNSON, Maple Leaf Purity Flour Mills Co. Ltd., Winnipeg, Manitoba

Secretary-Treasurer: S. KUHLE, Ogilvie Flour Mills, Winnipeg

Meeting place: Grain Exchange Building, Winnipeg

Meeting date: Third Tuesday of each month, Oct. to Apr.

Northern California Section, No. 15

Chairman: WALTER F. BROOM, General Mills, Inc., San Francisco, Calif.

Vice Chairman: WALTER S. HALE, Western Regional Lab., Albany, Calif.

Secretary: JAMES C. FINLEY, Langendorf Assoc. Bakeries, San Francisco, Calif.

Treasurer: WESLEY M. NOBLE, Peerless Yeast Co., San Francisco, Calif.

Meeting place: Not regular

Meeting date: First or Second Wednesday of month, October through June

Southern California Section, No. 16

Chairman: DAN MCPHERSON, General Mills, Inc., Los Angeles, Calif.

Vice Chairman: ARNIE KOSKI, Pillsbury, Los Angeles

Secretary: CORA MILLER, U. C. L. A., Los Angeles, Calif.

Treasurer: JOE TOPPS, California Milling, Los Angeles, Calif.

Chesapeake Section, No. 17

Chairman: KENTON L. HARRIS, U. S. Food & Drug Admin., Washington 25, D. C.

Vice Chairman: O. L. KURTZ, U. S. F. D. A., Washington, D. C.

Secretary-Treasurer: ROBERT BEATE, Orb Industries, Media, Pa.

Meeting place: Not regular

Meeting date: Third Thursday of Sept., Oct., Nov., Jan., Feb., March, Apr.

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BOOK reviews

Research on the Science and Technology of Food Preservation by Ionizing Radiations, by R. S. Hannan. Chemical Publishing Co., Inc., New York, 1956. Price, \$4.50. Reviewed by GEORGE E. DANALD, Quartermaster Food and Container Institute, Chicago.

As a complete report on radiation preservation of foods this book is superb. So far as this reviewer knows it is the first such in the field. While based largely on Dr. Hannan's earlier report for the British Department of Scientific and Industrial Research, it has been brought up to date at least through 1954 and cites many studies made in this country as well as by Dr. Hannan's group in England. Obviously in so rapidly growing a field as this, even two years' time yields a certain amount of new data that serve to render the book somewhat obsolete. This is not particularly significant for those who are just entering or considering entry into this area, since the fundamentals are there. The historical record is presented capably. Those who need the "latest results" must, as in any new technical field, consult current journals and read the original reports from a large and growing list of workers in this area (notably, in this country, reports of research under the extensive Radiation Preservation of Foods Project of the Quartermaster Corps, U. S. Army).

The approach used and organization of material are excellent. Properties of radiations useful for food purposes are given first; then the sources of these radiations are covered. Both are treated so that food technologists, bacteriologists, chemists, and other technical people who

may not have a background in modern physics can absorb the material easily. Physicists will find the treatment accurate, although purposely at an elementary level. Protection of personnel from the radiations used is treated briefly but adequately. A short chapter on dose and dose measurement completes the physics aspects of the volume.

Effects of radiations on microorganisms and on important constituents of foods comprise the "meat" of the work, amounting to more than a fourth of the whole book. Beginning at the simplest level in chemistry, the discussion moves forward with great thoroughness through complex vitamin chemistry. No attempts are made to elucidate reaction mechanisms, but rather the effects of radiations are presented, with copious references to original work.

Next, radiations' effects on whole foods are considered under the categories animal products, vegetables and fruits, and miscellaneous products including processed foods, spices, alcoholic beverages ("not encouraging"!), and even a brief discussion of packaging materials.

Attention is devoted to lower radiation dosages than those required for sterilization and their use for deinfestation, pasteurization, and inhibition of sprouting. The book concludes with a general treatment of acceptability of irradiated products and the probable economics of the process, among other subjects.

A summary makes six points, five of which are well substantiated by the textual material. They are:

1. Gamma and soft x-rays along

with "cathode rays" (i.e. electron beams) are the radiations of choice, and useful sources of these are available and probably economically feasible; but "developmental difficulties must be overcome, however, before widespread application in the food industry can confidently be envisaged."

2. Sterilization with radiation is entirely possible but some damage occurs at the same time. This concerns chiefly odor, flavor, and color in animal products and, to a lesser extent, in fruits and vegetables which do, however, also show some texture loss. Process variables can be used to control some of these effects.

3. Foods subjected to lower dose levels suffer less from the limitation in No. 2 above, and this is where first commercial applications, if any, are to be expected.

4. Medium dose levels for pasteurization or extension of shelf life, the author feels, have been insufficiently investigated to indicate whether or not they will eventually be competitive with conventional procedures.

5. No evidence of the formation of acutely toxic compounds is found, but acceptability of irradiated food for human consumption on a sensory basis has yet to be demonstrated.

The sixth statement concerns auxiliary uses such as irradiation of packaging materials.

The type used is small and not easy to read. The unusually complete bibliography and the carefully prepared index are of great value.

In its entirety, this book provides the single most important reference in this new field of food technology.

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"The Pharmaceutical Industry" by John O'Neill Closs is one of a series of Vocational and Professional Monographs used in connection with guidance activities wherever general counseling work is conducted, and for individual reference purposes in the choice of a career. Each of the series includes material on history of the occupation or industry; qualifications for employment; training required; methods of entry; opportunities for advancement; earnings; general trends; sources of further information. (Bellman Pub. Co., P.O. Box 172, Cambridge 38, Mass. 28 pp. \$1:00.)

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